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ACCOUNT OF THE CINCINNATI MEETING

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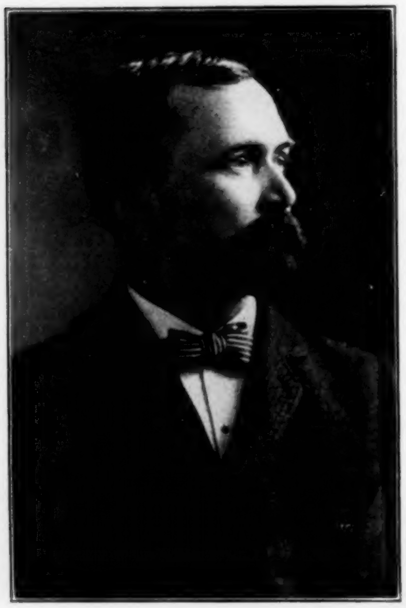

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Cincinnati Executive Committee, in Charge of the Spring Meeting, 1917

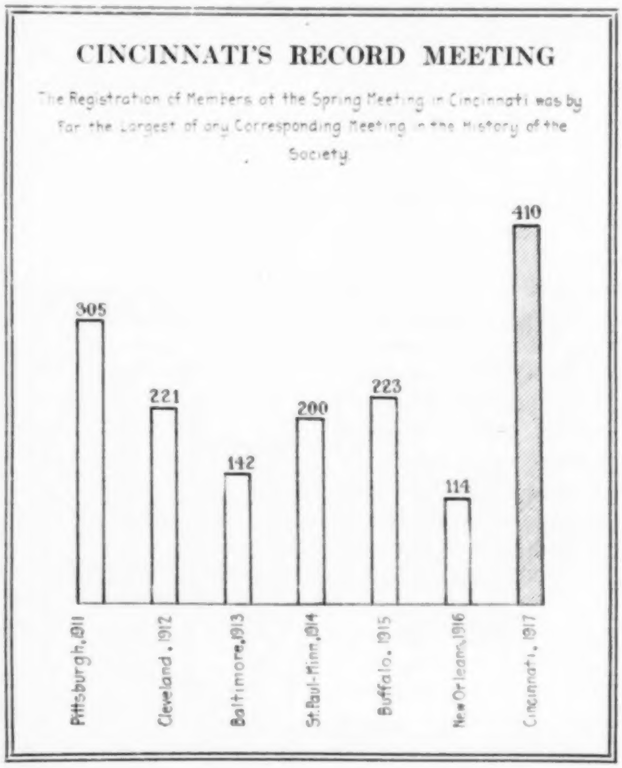
THE SPRING MEETING

WHILE not exactly logical to begin an account of the 1917 Spring Meeting in Cincinnati with a statement of the resolutions made in favor of the Cincinnati Local Committee at the close of the meeting, these resolutions so adequately express the sentiment of the gathering that perhaps the illogic may be excused. The resolutions follow:

WHEREAS, The American Society of Mechanical Engineers, assembled in convention May 21 to 24, 1917, at Cincinnati, Ohio has received a most cordial and spontaneous welcome from the members and friends of the Society in Cincinnati and vicinity; and has enjoyed the splendid coöperation and support of the local committees, through their tireless efforts on behalf of the Society, and their faultless preparation for the meeting, without which a convention of so marked a degree of excellence would have been impossible; and

WHEREAS, The visiting members and guests have been the recipients of a remarkably diversified and delightful entertainment bountifully provided on every occasion, and have had the opportunity to view many of the industrial wonders and other notable attractions of this remarkable center:

BE IT RESOLVED, That on behalf of the Society and of the visiting members and guests, a vote of thanks be extended to all who have participated in these substantial evidences of friendship and goodwill, with the assurance that such a formal resolution is but a poor and outward symbol of the deep sense of gratitude which each visitor personally feels. Further, that the Secretary be instructed to extend the thanks and appreciation of the Society, by written letter, to the local Executive Committee and the other local committees.



Those who were so fortunate as to be able to attend the meeting will testify that these resolutions are in nowise overdrawn. The Society did receive a most cordial and spontaneous welcome, the visiting members and guests being the recipients of a delightful entertainment. Evidences of goodwill were many, and the meeting was a complete success both from a professional and social point of view.

The headquarters was at the Hotel Sinton, and the total registration at the convention was 868, of which 410 were members and 458 guests. This was by far the largest attendance at any Spring Meeting the Society has yet held. The registration of members at the last six spring meetings is strikingly compared on the chart on this page, and shows the Cincinnati attendance far and away in the lead, in spite of the present national emergency exercising great restrictions on the time of professional men.

The exceptional attendance was no doubt largely attributable to the inclusion of sessions on munitions manufacture in the professional program. So many mechanical engineers and manufacturers throughout the country are expecting shortly to concentrate their whole efforts upon munitions work, and so many took advantage of the exceptional opportunity offered to benefit by the experience of those who have been devoting their energies to this class of work for nearly three years.

Another contributing factor to the large attendance was the holding of a joint session with the National Machine Tool Builders' Association. This is the first time such a session has ever been held. The presence of the Machine Tool Builders in convention at the same headquarters and at the same time as the Society contributed no small part to the success of our meeting.

The remarkable success of the Spring Meeting in all its features, however, must be directly attributed to the broad vision of the Cincinnati Committee, the systematic way in which its plans were laid, and the untiring efforts of its members in the execution of these plans. The members of the Executive Committee for The American Society of Mechanical Engineers were F. A. Geier, Chairman; G. W. Galbraith, J. T. Faig, W. G. Franz and George Langer; and for the National Machine Tool Builders' Association, J. B. Doan, Chairman; A. H. Teuchter, F. A. Geier, C. Wood Walter. A large number of sub-committees were appointed, all of which deserve the greatest credit for the perfection of detail in the conduct of the meeting. The Entertainment Committee, consisting of H. M. Norris, Chairman; A. J. Baker and A. A. Thayer, were constantly on the alert to see that no act should be omitted which would contribute to the pleasure of the guests. An account of the various entertainments will be found in the Society Affairs Section of this issue.

The social events began with an informal reception on Monday evening in the ballroom of the Sinton, with an address of welcome by the Mayor of Cincinnati and reply by President Hollis, followed by stereopticon views and dancing. The big social event for the members was the smoker on Tuesday evening, at which they were patriotically greeted at the Business Men's Club by the "Spirit of '76," and conducted to the assembly hall transformed to represent Losantiville, the Cincinnati of pioneer days, but modernized by brilliant kaleidoscopic lights. The evening's entertainment consisted of no less than eighteen numbers, concluding with the very gracious presentation by the Local Committee of a choice piece of Rookwood pottery to President Hollis.

The delightful boat ride on the river, the reception at the Country Club and the excursions to various institutions of the city and many of the modern manufacturing plants, all were greatly enjoyed. Further, Cincinnati's two dramatic

schools both contributed entertainments which will long remain in the memory of those who were so fortunate as to witness their performances.

The professional program arranged for seven professional sessions—two munitions sessions, one machine-shop session, one gas-power session, one industrial-safety session, one general session, and one joint session with the National Machine Tool Builders' Association. On account of the lively interest developed in the munitions sessions, these were ultimately expanded into three sessions.

The joint session with the National Machine Tool Builders' Association was a noteworthy event arranged by the Local Committees to show the consideration which is being given in Cincinnati to the humanitarian side of engineering. The addresses were by Dean Herman Schneider, the exponent of the coöperative system of education so successfully developed at the University of Cincinnati; and by Dr. Otto P. Geier, medical director of the Cincinnati Milling Machine Company, dealing with the work of the socially minded physician in industry. Both addresses touched a high plane and were an inspiration to the audience which filled the large ballroom of the Hotel Sinton. This joint session was followed by a timely motion-picture exhibition, arranged by *Machinery*, showing the processes of manufacture of 9.2-in. shells.

As usual at the Spring Meeting, the sections of the Society, through their representatives, showed themselves to be very much alive, and enthusiastic conferences were held at which there were members in attendance from eighteen different cities.

The Cincinnati Committee prepared a complete program of the professional and entertainment features for our own Society and for the National Machine Tool Builders' Association.

In what follows is given a running account of the professional sessions with abstracts of such parts of the discussion as it is believed will be of greatest interest to the membership, while additional notes will be found in the Society Affairs Section. The professional papers have already appeared in the May issue of THE JOURNAL.

MACHINE SHOP SESSION, TUESDAY MORNING

THE Machine Shop Session was called to order by Howard P. Fairfield, Secretary of the Sub-Committee on Machine Shop Practice, for the presentation and discussion of three important papers: A Foundation for Machine Tool Design and Construction, by A. L. De Leeuw; Machine Shop Organization, by Fred G. Kent, and Metal Planers and Methods of Production, by Charles Meier.

The session was well attended, a number of the recognized authorities on machine-tool design, construction and operation being in the audience, as well as many of the prominent machine-tool builders in Cincinnati, and the discussion was very representative and brought out many points of value.

As was anticipated, Mr. De Leeuw's paper in particular, embodying a questionnaire upon matters which should be settled before the design of machine tools can proceed in a thoroughly scientific manner, brought out the largest volume of discussion of the three papers and occupied most of the session.

MR. DE LEEUW EMPHASIZES THE NEED FOR RESEARCH IN CUTTING METALS

In presenting his paper, A. L. De Leeuw said that in it he tried to call attention to the fact that one of our biggest industries, the machine-tool industry, was not based on scientific principles, and yet it seemed that a scientific foundation would be perfectly possible. All the branches and all the phenomena of the cutting of metals could be reduced to mathematics, and this paper called attention to the fact that no branch of engineering progressed with any rapidity or certainty unless its facts and data were reduced to mathematics. Perhaps one of the reasons why the cutting of metals had not progressed along scientific lines was because it had been done for so long and by so many people.

The author further pointed out that the foundation for the design and construction of machine tools would probably lead to very important results. Some action should be taken toward the establishing of this foundation, and he hoped it might be taken under the auspices of the Society.

What was immediately needed was a research into the functions and actions of the cutting tool, the action of the cutting lubricant, etc. Experiments already made by him were outlined in the paper, and suggested lines of further experimentation were indicated.

The paper was discussed by Albert Kingsbury, H. Wade Hibbard, R. Poliakoff, A. Lewis Jenkins, Leon P. Alford, Frederick A. Waldron, Carl G. Barth, Arthur J. Baker, Charles Fair, Luther D. Burlingame, Ralph E. Flanders and Richard T. Wingo.

Albert Kingsbury contributed a written discussion of the action of lubricants on metal-cutting tools, in which he said that it was very well known that a proper lubricant applied to tools when cutting tough metals improved the cutting, but it was not obvious how the lubricant acted, since the cutting edge of the tool was apparently buried in the metal, and therefore it was not readily seen how the lubricant could reach the cutting edge.

He had made an experimental study of this question about the year 1895. A mild-steel bar was mounted in a lathe, held by chuck and center rest, and was cut by a parting tool with one side flush with the end of the bar. A microscope magnifying about 30 diameters was placed for examination of the chip during formation. The bar was rotated very slowly by using the back gear and pulling the belt by hand.

Figs. 1, 2 and 3 showed roughly successive stages of formation of the chip. The most important phenomenon was the fact that a crack in the metal preceded the cutting edge of the tool at all times. The crack began at the point C in Fig. 1; it extended in substantially the direction of the finished surface of the work, as in Fig. 2, up to a certain point where it suddenly turned outward about 45 deg. as in Fig. 3.[1] This action was cyclical, beginning again when the point C reached the cutting edge. The successive surfaces of these cracks formed the finished surface of the work, if the tool was sharp, thus giving the well-known cross-banded appearance of the tool marks; but if the tool was dull there was more or less rubbing of the tool over the surface after the cracks were formed, altering the appearance of the surface very noticeably. Oil being applied to the work, as the crack extended the oil was seen to flow into the crack, the flow being made evident by the motion of minute particles of steel suspended in the oil.

[1] Similar descriptions of the formation of the chip are given in Trans. Am.Soc.M.E., vol. 28, p. 75 and p. 333.

Thus the oil was enabled to reach the top surface of the tool, even to the cutting edge. The principal effect of the lubricant appeared to lie in the reduction of friction on the top face of the tool; this increased the frequency of the cyclical breaking of the chip, shortened the chip segments and reduced the length of the cracks in advance of the cutting edge, and thus made the finished surface smoother.

This phenomenon explained several facts regarding the lubrication of cutting tools, well known to machinists, as follows:

a Good lubricants of rather high viscosity, such as lard oil, were very effective when the cutting speed was slow, as in tapping and reaming by hand, but if the cutting speed was high, as in high-speed milling and drilling, lubricants of very low viscosity, such as soda water or soap and oil emulsions, were more effective. The lubricant was forced into the vacuum in the crack mainly by atmospheric pressure (capillarity probably being secondary if the cutting speed was high). Therefore, if the viscosity of the lubricant was high the cracks might not be filled fast enough.

FIG. 1 FIG. 2 FIG. 3

FIGS. 1 TO 3 SUCCESSIVE STAGES IN FORMATION OF CHIP

b In the case of a parting tool cutting off a bar, the tool lubricated well at the beginning of the cut, but not when the cut became deeper. In the deep cut the chip was "upset" and filled the slot, and therefore the lubricant could not readily enter the cracks from the sides of the cut. It had been found efficacious, in large work, therefore, to use two tools simultaneously in parting or slotting cuts, the leading tool being narrower than the following tool; thus both tools were fairly lubricated, the leading tool from both edges, and the following tool from one edge of each of its two narrow chips.

c In finishing cuts with broad tools, the lubricant must penetrate the cracks for long distances; thus it was necessary to run slowly and to use thin lubricants such as kerosene or turpentine. More viscous lubricants might be used if the speed of cutting were exceedingly slow. There must be sufficient time for the lubricant to flow in the cracks from the edges to the center of the cut.

d In slab milling, etc., it was found advantageous to notch the cutting edges at frequent intervals; this broke the wide chips into narrow ones and thus favored the entrance of the lubricant.

e In general, the more viscous lubricants were used only for slow speeds or narrow cuts, the less viscous for higher speeds or wider cuts. Even a poor lubricant, if it flowed readily enough to penetrate the cracks rapidly, was more effective than a good lubricant which was too slow in getting to the spot where it might be effective.

H. Wade Hibbard said that, as in thermodynamics, the fundamental consideration in machine designing was the ultimate constituency of matter. In a piece of steel there were millions of atoms held in relation to each other by "springs" —forces of cohesion and repulsion. If this piece of steel were heated, the forces that tended to separate the atoms were increased; if cooled, these same forces were diminished. To make a study of how to cut a piece of steel, one must consider what was being done with these "springs" connecting the atoms together.

All the forces applied to a piece of steel in cutting it, or in testing it, as Mr. De Leeuw had shown in his diagram of the tension test of a piece of steel, could be resolved into just two kinds of forces, the normal forces, plus or minus, and the tangential forces, either plain shear or rotating shear.

"Upon this theory of the ultimate constituency of matter, and the forces which hold atoms together," continued Professor Hibbard, "some of the things that puzzle us in machine-tool designing are made more clear. For example, the author asks, 'When we turn up a narrow disk by means of a square-nosed turning tool, of which the width is greater than the width of the disk, is the action of removing the chip purely a matter of tension? Or, if not, what is it?' No, it is not purely a matter of tension, because according to the above reasoning both normal and tangential forces are acting on the 'springs' holding the atoms together. Also, 'What is the nature of the lamination of the chip?' Its nature is almost purely the action of the tangential force upon those 'springs' holding two adjacent layers of atoms together.

"'We do not see at the present time how it is possible for the lubricant to influence the size, yet that it does do this has been observed a great many times,' the author states later. That, I believe, if we think of these two kinds of forces, the normal and the tangential, means that by lubricating the top of the tool we reduce the normal force, necessarily. In other words, we reduce the compression of the chip in the direction of the length of the chip, and that, of course, has its effect upon the size of the turned part which is left, after the part has been turned by the tool."

R. Poliakoff[1] said that in Par. 32 the author referred to a tool which was shown in Fig. 4, and observed that that tool after it had been used began to show scratches. Now, he did not know what was the plan of the tool, whether it had a round edge or not, but, if so, the scratches might be attributed to the fact that in leaving the work internal friction was developed among the elements of the chips, which caused them to rotate, one against another, and in this way to scratch the tool. He had started some experiments along this line, but had to abandon them when he came to the United States, but he hoped sometime to continue them. It would be better, perhaps, just to drill out the top of the tool, instead of making it flat, which would give a better tool, and also one that would take less power.

Regarding the circular tool, described in Par. 35, he believed Mr. De Leeuw originated that tool some two and a half years ago. He did not know how much experimenting had been done on the tool in this country, but as soon as he had read about it he had made one on the same lines, and wanted to experiment with it, but, unfortunately, was obliged to go away. However, in a remote factory in the Ural Mountains they did make a tool similar to that shown by Mr. De Leeuw, and they found that it gave them a great saving.

He thoroughly agreed with what the author said under the head of "Suggested Lines of Experimentation," but could easily see some objections from the so-called practical viewpoint—from the point of view of the practical shop man.

[1] Technical Institute of Moscow, Russia.

As Mr. De Leeuw suggested, if such low speeds were taken, the ordinary shop man would say, "that's all right." It might be all right in theory, but how about the practice. Perhaps the practical conditions would be quite different. In connection with this, he wanted to mention that very little in the way of experimental data had been published along these lines of cutting, especially as compared with the ordinary shop practice. Edward Herbert, however, had been working alone these same lines for some time, had published some results which were very interesting with reference to the finishing cut, and had shown that the tool failed in a different way from what it did on the ordinary roughing cuts. When Mr. Herbert presented his valuable paper on this subject about four years ago, he had to encounter this same objection of impracticability on the part of the shop man. In order to meet this objection to a certain extent, Professor Poliakoff started some experiments on the finishing tool from the practical view of the shop man, and under the ordinary shop conditions, and had found that the result of his experiments exactly corresponded with Mr. Herbert's under ordinary conditions of speed. These results were printed in a paper about two years ago.

In Par. 30, it was stated by the author that the results should be in the direction of the saving of power. As to this, he would say that a Russian professor, Mr. Simon, had experimented along these lines, and published the results of his investigations about three or four years ago; they showed, or tended to show, that with different lubricants the consumption of power was different, other conditions being the same. While a saving in power might not always be necessary, yet by diminishing the power required, the strain on the machine would be decreased. So that the investigation of the lubricants used in cutting was naturally of very great importance.[1]

A. Lewis Jenkins said that, at the suggestion of Mr. De Leeuw, about three years ago a set of stationary cup-shaped lathe tools, similar to the tools shown in Fig 6 in the paper, was made at the University of Cincinnati. Something like 600 tests were made to compare the power required for the De Leeuw tool, as they called it, with a standard Taylor tool made by the O. K. Tool Company.

The cutting angles were varied from 16 to 90 deg.; the diameters of the tools were varied from 1.25 to 1.4 in., and the work specimen was a piece of steel 4 in. in diameter and 30 in. long. The machine employed was the LeBlond 21-in. all-geared-head lathe.

The tests were made by using a cradle dynamometer, and after taking the readings for one tool at a given feed, depth and speed it was removed and the other tool put in place without changing the speed, feed and depth of cut. The conditions of operation were therefore exactly the same for both tools.

The De Leeuw tool gave a higher finish than the Taylor tool. The De Leeuw tool made no chatter marks when the work was greater than 2 in. in diameter and the cutting angle less than about 80 deg., even on the heaviest cuts taken. The Taylor tool chattered on all diameters when taking the heaviest cuts. The results of these tests showed that a De Leeuw tool having a 40 deg. lip angle required about 90 per cent of the power required to drive a Taylor tool under the same conditions. For cutting angles greater than 60 deg. there was practically no difference in the power required for the two types of tools when operated under these conditions. The feeds varied from 1-64 in. to 1/8 in. and the depth of cut varied from 1-32 in. to 1/8 in.

Leon P. Alford said that a recent question before the Research Committee of the Society was: "What can this Committee do at the present time which might have a beneficial effect in helping this country at war?" One of the sub-committees brought in the suggestion that very little had been done in the direction of a study of the action of cutting tools and the cause of chip formation, and it was decided to concentrate the efforts of the Committee upon that topic. As a member of the Research Committee, he would like to ask Professor Jenkins if he would place in the Committee's possession all the information he had in regard to the series of tests described, and also if Professor Poliakoff would do the same thing in regard to the investigation he had made and from his experience with this tool in the Russian rifle works.

Richard T. Wingo thought that one of the things the Society could do to advantage was to organize the machine-tool shops, with a view to exchanging information regarding tool equipment and methods. His reason for saying that was that it would be found, in going into one machine-tool shop, that it was doing a certain thing in a certain way, but if a competitor came along, very frequently it would be found that that shop was under lock and key because it did not want to show a competitor how it was doing its work.

Of all the branches in mechanical lines, the automobile had brought about the most remarkable results, and it had been done by one concern showing another what it had been doing in every detail.

Frederick A. Waldron thought that in all this work there was a sort of eternal fitness of things, which should lead us to begin, if possible, with a classification of machine tools. This should be confined to machine tools in general, so as to cover the paper now presented.

The classification took the following form in his mind: *first*, machines of convenience; *second*, machines of precision; and *third*, machines of displacement. The machine of convenience was one principally for a jobbing shop not having too heavy work, in which the convenience of the operator, the interchangeability of face plates, of centers, gears, feeds, etc., was paramount. Machines of precision were designed principally for use in tool-room work and on work requiring the greatest precision. Machines of displacement were intended to remove large quantities of metal in the minimum time, with the maximum life of the tool and with the maximum life of the machine.

Carl G. Barth said that he was delighted with the manner in which Mr. De Leeuw had pointed out the part that mathematics played in the development of engineering, for there were as yet too many among those who practiced engineering who were sadly lacking in the everyday recognition of that fact.

However, he believed that, when it came to the art of cutting metals, we already had at our command a wealth of information that should be made more generally available and applicable in everyday machine design and machine-shop practice before we undertook to spend money and efforts in further experiments and investigations, even along the undoubtedly fundamentally sound and interesting lines suggested by Mr. De Leeuw, which at the same time did not promise enough in early results that might be immediately applied to increase the production of the present machine-tool equipment of the country through the present workers and their foreman.

[1] The above notes convey the purport of Professor Poliakoff's remarks. His full discussion, with illustrations will be published later.

Having for some fifteen years made it his principal specialty to increase the production of machine shops, he had, after all, found that the greatest difficulty in the way of increased efficiency was that of educating workers and their foremen to see the fundamental principles underlying their work.

In his judgment, the Society could do more immediate good by appointing a committee to gather together and formulate the knowledge now available, and then perhaps supplement this by further experiments with the various forms of cutting tools already in use; this committee finally instituting a regular campaign of education of the metal workers of the country to utilize the information compiled.

Personally, he stood ready to coöperate with such a committee and to give up the information he had, and to divulge the means he had from time to time devised to make this readily applicable in practice.

When he offered this counter suggestion to Mr. De Leeuw's proposition, it was merely as a practical expedient to obtain results quicker, for he was sure that he believed fully as much in getting to the bottom of things as did any other member of the Society, Mr. De Leeuw not excepted.

He had received his principal training through his coöperation with Dr. Taylor, and the latter had always said that it was better to concentrate on making use of whatever useful facts we had than to spend time on ascertaining even better facts.

Arthur J. Baker, referring to the type of turning tool shown in Fig. 4 of the paper, said that about eighteen years ago, in England, his firm was making tools for turning shackle pins for the Admiralty. These were large tapering pins, say, two or three inches in diameter at the small end, and running up from six to twelve inches in length, and were turned on rather large lathes. When they used the standard type of tool, the machine would not take the cut at a feed sufficient to enable them to produce the pieces in the time that they felt they should be produced in; so they slowed the machine down, but failed to reduce the feed. They then made a flat-topped form tool for the roughing operation, and sunk into its top surface a half-round cutter which left a flat lip or land about 1-32 in. wide on all of the cutting edges. This construction reduced the friction and enabled them to take a cut of almost twice the average that they were able to when using the standard type of cutter.

In regard to the circular turning tool shown in Fig. 9, he had been instrumental in placing a number of those tools in various lathe plants around the country. Some of the users employed them in experiments, and some, he rather thought, did not believe they were very practical and did not go further with them, but the Pennsylvania Railroad, at Altoona, used them on some of their larger rods, with quite satisfactory results, except for this one drawback: that the circular tool could not be used on any job where it was desired to cut up to the shoulder, because the retention of the rather thin cutting edge between the chip and the work usually caused a breaking as the tool was withdrawn. So that the real virtue of a tool of that kind was confined to its use on work that enabled one to pass quickly across the surface. The American Blower Company, of Detroit, had used one of these tools for turning pulleys, and the results were highly satisfactory indeed.

The cutting speed used in turning the Pennsylvania Railroad rods was about 65 ft. per min. They made no attempt to get high speeds. The cast-iron pulleys turned at the American Blower Company, in Detroit, were run approximately 130 ft. per min.—the iron was tolerably hard—which was the highest speed they had been able to use.

Luther D. Burlingame said he would like to offer a resolution, based on the idea that Mr. De Leeuw had brought forward a work of real importance and a work well worthy of attention, that the meeting urgently request the Council of the Society that suitable funds be put at the disposition of the Research Committee in order to carry on the experiments in regard to cutting tools, along the lines referred to in Mr. De Leeuw's paper.

Ralph E. Flanders asked whether it would be possible to secure the coöperation of Mr. Barth and his associates with the Research Committee, or any other proper committee that might be formed. It would seem to be possible, for instance, to put the information on lathe tools, speeds and feeds that was obtained by Mr. Taylor's work into some concise form so that it could be used by engineers anywhere in the machine shops of the country. It seemed to him that this would be a simple, direct and patriotic service that could be rendered to the country just at this time.

Charles Fair said that he agreed with Mr. De Leeuw that we would not get very far in our investigations so long as these investigations and tests were conducted by individuals in a more or less haphazard sort of way, and almost invariably by some short-cut method which usually resulted in not getting the necessary data that would make the tests of any value. It was too bad that more methodical consideration was not given to such investigations. He knew of no body more fitted to undertake this work than the A.S.M.E., and he would therefore like to suggest that this Society should carefully consider the subject with a view to the laying out, if possible, of some definite plan of action not only to be followed by the Society, but elastic enough so that it would be useful to the individual investigator who cared to coöperate with the Society. Much time was being wasted by a repetition of what might almost be called standard tests, while little thought was given to that which might seem to be secondary, but which, in reality, might be of great importance.

While he thought that some of the questions raised by Mr. De Leeuw might be satisfactorily answered, he was afraid that it would require considerable investigation before he would venture on even an intelligent guess as to the answers to a number of others.

CLOSURE BY MR. DE LEEUW

The author said, in closing, that Professor Hibbard had gone several steps further than he would want to go at the present time. We did not yet know very much about the ultimate constituency of matter.

In answer to Professor Poliakoff's question as to the shape of the tool that was used, he would say that this tool was of the square type, with a slightly rounded column and with an angle in both directions, and instead of the angle a groove was substituted in the direction of the feed. Most of the metal was not flying up tangentially to the direction of cutting, but it was flying off at right angles to the direction of the feed. The scratches were all in that direction.

There was no particular way in which the tool would fail; it would sometimes fail near the point, as if the tangential flow of metal would cause it, but more often it failed in the other direction. The importance of the scratches was simply that almost immediately after they began to form the tool would fail, showing, therefore, that the greatly increased friction over the surface of the tool caused the breaking down of

the tool, probably on account of heat, and possibly on account of the increased force there.

Professor Poliakoff also mentioned that the idea of a very low speed would not appeal to the man in the shop. From what he knew about the man in the shop, he would not think that any experiment of that kind would appeal to him. The fact was, the man in the shop was not inclined to do experimenting and was very much opposed to it.

He was heartily in accord with Mr. Waldron's idea of a classification of machines. It was getting time that we should know what we were talking about. We were talking about machine tools, about a lathe, for instance, but a lathe might be used for so many different purposes. However, he believed that a very large portion of the work done by machine tools in modern industries was work of displacement. The lathe, as constructed at present, was utterly unfit for using a lighter tool. The conditions were so radically different that he did not believe the lathe could be used as it was at present. In the first place, a very much larger proportion of the power consumed had to go through the lead screw. In the second place, in order to get the best results the lathe should run at a very high speed. And, running at a high rate of speed with a bar perhaps five feet long, running 1350 revolutions, was a very dangerous proceeding. If the end should run off there would be some disaster. Furthermore, it was not possible to run the ordinary lathe at the speed required for that tool. One of the things to be done would be to arrange a lathe so that such a tool could be used to advantage. Still another thing: under those tests the carriage traveled 47 in. to the minute. Now, at that rate, it was not possible to throw out the feed by turning the knob; it was possible, but not within half an inch. In other words, if the left hand should fumble with that knob for just an instant—one second—it would run up against the operator's shoulder and there would be something doing! In regard to what was said about slide rules, that was really a matter that he did not wish to discuss; he did not wish to say whether a slide rule was going to improve the performance of the lathe or not; in fact, he knew it did, but that was a matter of management—a matter of the use of the knowledge we had at the present time. It was very far from his idea to suggest that we should not use the knowledge we had; his paper was not aiming at that at all. He neither advocated neglecting to use the knowledge we had, nor did he advocate its use. To advocate not using the knowledge we had would be a piece of foolishness, and to advocate using it would be almost an insult to the engineers present. What he was urging was to gather up knowledge. Whether it was practical at the present moment or not had nothing to do with the question. We all knew that before knowledge could be made practical, the knowledge must be available. There was no use in talking about the particular nature of the thing when we did not have the thing. The main thing that he would urge was that they should go forth and get it, and that they should try to find out some of the elementary knowledge about the art or science of cutting metals. Personally, he felt that when we had that knowledge we would be able to use it. The American nation had shone especially in the application of knowledge, but it had not shone in the gathering up of knowledge. He had no doubt whatever that there were a great many men in this country who were just as capable of finding and gathering up knowledge as there were abroad, but he believed that heretofore we had had the habit of looking at the mere gathering up of knowledge as something that had no particular value, but as merely a sort of a plaything for the professor who sat in his study and did his thinking and played with his thoughts, and then wrote it all down in a book and the book was put somewhere on a shelf in some library and was forgotten. But that should not be the case. Of all the knowledge that we gathered up, there might perhaps be a certain percentage that was not immediately usable, but he could not think of any great, or even fairly notable, discovery in science that had been made that wasn't at the present time employed in actual practice. If Professor Roentgen had first said, "Let me see what I can use X-rays for," and then, after he had made out what he could use them for, had said, "Now, let me see where that X-ray is—let me hunt it up"—we would have had no X-rays. If Professor Becquerel had first asked himself what he could do with those peculiar Becquerel rays, and how he could use them for transmitting knowledge from one end of the earth to the other, he never would have found the Becquerel rays; the Hertzian violet rays never would have been found, and we wouldn't have any violet rays at this time. Those simply gathered up the knowledge, and then there were other men who were, perhaps, working on different lines who took that knowledge and applied it. So that his plea was for definite knowledge. He had a profound belief in the ability of the American engineer to apply that knowledge after he had found it.

MR. KENT PRESENTS HIS PAPER ON MACHINE SHOP ORGANIZATION

In his paper on Machine Shop Organization, Mr. Kent outlined briefly the basic structure of an organization for a shop building the average line of machinery, applying his remarks to a shop employing 600 men or less.

It was the contention of Mr. Kent that the average shop should have the following departments: Works office, engineering department, pattern shop, tool design and storage, tool making and repair, plant engineering and power, machinery, and erection.

This paper was discussed by J. M. Spitzglass, Mark H. Landis, Elmer H. Neff and A. L. De Leeuw.

J. M. Spitzglass related an experience in shop organization or reorganization which was rather the opposite of the experience cited in the paper.

In this case, the shop was a very small one, having a few groups of two or three men in each group. The management of the shop was visibly incapable, the equipment poor, and the material, while not poor, was very poorly applied.

He could not be present there all the time at the beginning of the reorganization work, but he placed at the shop a very bright young man, in fact a genius in mathematics and system, to make a systematic study of the work and to help in the reorganization of the methods and workings in the shop.

During the first two months he had his hands full in keeping this young man back. He simply could not wait, but wanted to revolutionize, and, in fact, did revolutionize, many things from the very start.

Of course, friction arose from the first moment. The foreman of the shop openly objected to the various innovations. The men in the shop did not like them, though they seemed to be to their advantage, and Mr. Spitzglass, himself, had continuous missions on one side to pacify the shop, and on the other side to keep the young man back, and the latter was the harder job.

The author had pointed out that the time study and the bonus system should be considered only after all other leaks had been attended to. We should consider the fact that in the case of office reorganization we had to deal with men who

understood us at once. They were with us and helping in every way and, therefore, office reorganization was comparatively easy.

When it came to the time study of the men in the shop, we had to deal with individuals who were certainly not with us at the start. If they had anything against us they would not express themselves, and we were working in the dark, which was one more reason for taking sufficient time before the work of time study and bonus system could be started in the shop.

Mark H. Landis said that discussion of the question as to whether it was always right to arrange machines according to their function, led him to state an experience in his plant.

On the small parts—gears, shafts, etc., and the small parts in general that were put into the stock room—it seemed better to have those machines arranged in departments, according to their function, milling department, etc.; but, for the heavy castings, beds, turrets, etc., it seemed preferable to arrange those in departments, according to the castings themselves. In his shop, about a year or so ago, they made a diagram of the shop and all the machines, showing the path that the heavy castings followed through the shop, and it amazed him to see what a tangle of lines represented the moving of the heavy castings. Such a tangle was inevitable unless the shop was so arranged that the castings followed more or less straight lines.

Elmer H. Neff discussed the point that "the inspection department must be answerable to the works manager or his assistant only." One of the largest plants and perhaps the most successful in the country was organized on that basis many years ago, and he believed that that was one of the principal elements in the success of the plant, as he believed it would be in any case where it was consistently followed out. He wished to emphasize that point, because he believed it to be a very important one. There were shops in this country today in which the foremen were allowed to override the work of the inspector, and the results, according to his observation, were always disastrous.

Adolph L. De Leeuw did not believe that it was possible to arrange the machines in shops as Mr. Landis recommended. So many different factors entered in that he did not think it possible to make a general rule. If one had a shop small enough and with a small line of production, producing only comparatively few things, the plan was perfectly possible. If, on the other hand, in that shop they were making 250, or even only 25 different things, unless the output of each of the different classes of machines was very large, he thought such an arrangement would be impracticable, and that that shop would probably be arranged so as to have the larger parts follow the same route as the smaller parts.

If one went still further and took a shop where they made not 250 different varieties but 3000, there would be a reversion and the machines would be placed in groups.

He said that at the plant with which he was connected, there was one shop that assembled the machines, and there were others to furnish the parts. For example, one of the parts was so small that a dozen of them could be put in the vest pocket, yet there was a shop comprising perhaps twenty, thirty or forty machines, that did nothing else but make that part. And yet, even in that establishment they departed from that system again, because when it came to making sheet-steel pressed parts, which had to be handled in such a different way, if these parts had later on to be milled or drilled, or have some other process performed on them, the work was thrown back into the drill department because there the skill and knowledge required to get the best results in the process was such an absolutely individual thing that it would not pay to have the parts distributed over the entire shop.

Though the press parts all ought to be kept in the press shop, yet there were parts which required such particular knowledge of the function of that part after it was made, that it was better again to put the presses in the department where the part was made.

This was just exactly the condition that would be found in most shops. No general rule could be of any value unless a very careful study was made of the individual requirements of that shop and of the parts made in it. There were certain screws made in the screw department, but there were screws made in other departments, too, because there the important point was to understand the requirements of that particular screw; that was of greater importance than the making of the screw mechanically.

He would suggest that in discussing the arrangement of machines in the shop, we forget all about any general rule that might be presented, or that ever had been presented, and study the problem as we found it.

Carl G. Barth wrote that as Mr. Kent's paper read in the main as if it had been written by someone directly trained in the art of managing by Dr. Taylor, he most heartily agreed with nearly everything it contained. What the author said about leaving such matters as time studies and wage-payment schemes to the last, when reorganizing a shop, he believed in so fully that he wished it could be made a law in our statutes; for the introduction of these features of scientific management before the proper foundation for them had been laid was doing a great deal of harm around the country, particularly as only too often the men entrusted with that kind of work lacked the necessary knowledge and experience to do it properly at any time.

The ideal way of effecting a reorganization of a shop undoubtedly was, as Mr. Kent said, by putting a competent man at the head of the organization to do the work; but, unfortunately, there were not enough of that kind of men to go around, so that there was still a legitimate field for the professional outside reorganizer. Such a man should, however, as had now been his own practice for some ten years past, to the greatest possible extent do his work through someone in the permanent organization, whose education in modern management methods thus became his principal task.

In nearly all the shops that he had reorganized, the product had been of such a nature that his efforts had been to group similar machinery together; that is, adopt what might be termed the functional arrangement of the machines; but under certain conditions it would be absolutely preposterous to do this, and no hard and fast rule could be laid down in this matter. Each shop became properly a study of its own.

H. Wade Hibbard said, in criticism of Par. 5, that a wage-payment scheme was not necessarily involved in time study. Certainly time study should come early, preceded by analysis of an operation into its elements, then timing the elements. Often it was found that the company was itself the greatest time waster, and this waste could be eliminated without any reference to the wage-payment system.

CLOSURE BY MR. KENT

Fred G. Kent, in a written closure, said that the discussion seemed to make it necessary to reiterate what was said at the

beginning of the paper; namely, that this paper was confined to the treatment of an organization employing from 300 to 600 employees engaged in producing an average line of machinery.

A great deal of the discussion about the arrangement of machines according to classes or according to the pieces produced was very interesting, but was beside the point so far as this paper was concerned. However, it seemed to him that in a shop of any size, if its product was subject to any variation at all and to alteration of design, there was a fundamental principle which made possible a fairly general rule.

The most important factor in the grouping of machines was the need for getting the greatest skill obtainable in the organization applied to each operation. Skill of operation would far more than offset very considerable expense in the transportation of material which might result from the necessity of moving pieces even of considerable weight over considerable territory. In other words, the man in an organization who knew most about screw machines, should have all screw machines in his department and be responsible for all screw-machine work. The man who had made a specialty of planing and who treated it as his life work, would know far more about his job and would take far greater pains in his work than any man who had charge of the manufacture of one piece requiring many different machines other than the planer, and this man whose specialty was planing should therefore have charge of all the planers in the shop and be responsible for all planing work.

He had tried to show at various points in this paper, and wished again to emphasize the fact, that the most important factor to be dealt with in the shop organization was the human element. This factor was, of course, the least subject to the exact operation of formal rules. It was never long the same in any one shop and never the same in any two shops, and it was the most important thing to consider in the question of the time at which it was most advantageous to take up time study.

It was, of course, never amiss for the foreman of a department to study very carefully the efficiency of any of the operations carried on in his department, and to suggest and carry out changes, but the bringing into the department of some stranger, or a man whom the workmen looked upon as a stranger, to carry on a scientific analytical study of operations, was a thing to be taken up only after all obvious leaks were stopped and the confidence of the workmen firmly established. In fact, it was his belief that reorganization could be carried on with the greatest profit where the fact of reorganization was kept very thoroughly in the background and even not suspected by the average workman. It was true that conditions might sometimes be so bad that violent action was the only possible means of introducing a remedy, but in general it was safe to say that the best types of shop organization were like the best types of life everywhere; they were a matter of growth rather than revolution.

MR. MEIER PRESENTS HIS PAPER ON METAL PLANERS

The paper entitled Metal Planers and Methods of Production, by Charles Meier, presented by the author, described the evolution of the planing machine to provide the increased speeds and power to develop the possibilities of high-speed steel and to meet the increasing necessity for greater production. The paper also analyzed the operation of the planing machine and showed how, by improved methods of setting the work, measuring for rough cuts, fitting for finishing cuts and changing tools, the production of the machine could be greatly improved.

Mr. Meier's paper was discussed by Charles Fair and Carl G. Barth.

Carl G. Barth said that Mr. Meier's paper was interesting, as it was probably the first attempt in the way of a published statement of the actual gains obtained by the use of aluminum pulleys instead of cast-iron pulleys on belt-driven and belt reversing planers, as first done by the Cincinnati Planer Co. However, on investigating the experimental data set forth in the tables, he had found them far from consistent.

Frequently during the past seventeen years he had had to conduct similar experiments with planers of various kinds, in order to determine the length of time it took them to make any length of double stroke between a minimum and the maximum of each one, for the purpose of incorporating this information on his Planer Time Slide Rule, and in making such experiments he worked on the theory that the time consumed in stopping and reversing the planer table at the end of each stroke must be independent of the length of the stroke, and that it could hence be considered equal to the time it would take the table to travel an imaginary addition to its actual stroke, at its full forward and return speeds. Thus, if l designated the actual length of stroke, and a this imaginary or ideal addition, then the total time for a double stroke would be

$$t = \frac{l+a}{v} + \frac{l+a}{V} = \frac{V+v}{vV}(l+a) = C(l+a) \ldots\ldots [1]$$

v and V being respectively the forward and return speeds of the table.

Similarly, for $l = l_1$ and $t = t_1$,

$$t_1 = C(l_1 + a) \ldots\ldots\ldots\ldots\ldots\ldots [2]$$

and dividing [1] by [2] would give

$$a = \frac{tl_1 - t_1 l}{t_1 - t} \ldots\ldots\ldots\ldots\ldots\ldots [3]$$

Thus the experimental determination of the time for each of two double strokes only was necessary for the derivation of the value of a, and hence, if three values of t were determined experimentally, these must result in three derivations of a that must substantially be alike, if the experiments were conducted with care.

Mr. Barth then showed that Equation [3] applied to the data in Table 1 of Mr. Meier's paper would give for cast-iron pulleys the following three values of a: 7.72 in., 4.08 in., and 13.48 in., which were far from substantially alike. For the aluminum pulleys were similarly obtained for a the three unequal values 4.17 in., 5.37 in. and 7.18 in.

However, while data obtained by experiments with two different strokes only were theoretically enough for the determination of the value of a, the foregoing investigation showed the necessity of taking at least three strokes, as Mr. Meier had done, and then in addition to this, to work with such care and circumspection that the three values of a independently obtained would be near enough alike for all practical purposes. His method was to plot, as in Fig. 1, the simultaneous values of l and t, with the latter obtained by means of a stop watch on which was read the time it took for the completion of an exact number of double strokes of a carefully measured stroke.

It would readily be seen in Fig. 1 how a was graphically determined by the straight line AB drawn to pass through the three points C, D and E, when these represented a set of consistent results obtained.

After similarly plotting all of Mr. Meier's results, and taking it for granted that a only and not C in equation [1]

was affected by the substitution of aluminum pulleys for cast-iron pulleys, he had by inspection attempted to eliminate the grossest errors of Mr. Meier's observations and to write equation [1] as

$$t = 0.0354\ (l + 1.125) \quad \text{for cast-iron pulleys}$$
$$t = 0.0354\ (l + 0.45) \quad \text{for aluminum pulleys.}$$

If he had succeeded in getting closely to the truth in arriving at these equations, the value of 1.125 ft. = 13½ in. for the cast-iron pulleys, as against only 0.45 ft. = 5.4 in. for the aluminum pulleys, was certainly the plainest way of showing up the superiority of the latter.

Mr. Meier gave the forward speed of the planer as 40 ft. and the return speed as 90 ft., which would make the value of C in these equations = $(90 + 40) / (40 \times 90) = 0.03611$; but the plots he had made seemed to indicate that this value was too high, so the value 0.0354 was chosen. However, assuming $V/v = 90/40$, or $V = 2.25v$, and writing

$$C = 0.0354 = \frac{V + v}{vV} = \frac{2.25v + v}{2.25v^2}$$

gave $v = 40.8$ ft. and $V = 91.8$ ft., which were not very far from the figures given by Mr. Meier.

In Par. 11 Mr. Meier made the unqualified statement that the aluminum pulleys also "effect quite a saving in power," and then stated, by pointing to the figures in Table 2, that for a 76 x 62 x 32-ft. planer this amounted to 25 per cent, while he evidently had in mind only the maximum power expended during the period of reversal.

As the power during reversal was principally expended in overcoming the inertia of the pulleys, the total amount of this power must be more nearly proportional to the weights of the respective pulleys, while the 25 per cent of greater peak load could be explained by the well-known fact that a belt would pull the most when it slipped the most, as it no doubt would when forced to stop and start the heavier cast-iron pulleys.

However, the power expended in reversing was of no consideration as compared with the wear and tear on the belts themselves and other parts of the reversing mechanism.

Charles Fair said that Mr. Meier had brought out a number of important points which should receive serious consideration. For a long time he had felt, as Mr. Meier did, that neither the planer manufacturer nor the planer user had given the question of handling the work or the cutting anything like the consideration it deserved. It was generally admitted, for instance, that higher cutting speeds were possible if the tool entered the work slowly and then speeded up, yet information was very meager as to how seriously this would affect the work.

On heavy roughing cuts the spring due to the increased pressure on the tool while speeding up in the work would probably be noticeable with tools not properly shaped. If only roughing cuts were required, a fine degree of accuracy would not be essential. If roughing and finishing cuts were made, he doubted if the inaccuracies, due to speeding up in the light cut, would be noticeable. From such tests as he had made this difference was not great. He had again brought up this question of speeding up in the work because, should it be required, it was very easy to accomplish with the reversing motor drives, as is also slowing down before leaving the work to prevent breaking out the metal.

Production on planers could certainly be speeded up by a more liberal use of jigs and fixtures and in many cases double sets of jigs could be used to advantage where considerable duplicate work was being machined. This would be particularly true in cases requiring time to properly set the work.

Mr. Barth was a little hasty when he criticized Mr. Meier's paper, largely, he would judge, on the grounds of its being practical only and not consistent, presumably, with his theory. In this particular case, however, the correct theory did agree with the facts. Mr. Barth's whole theory was built on an incorrect assumption, namely—"that the time consumed in stopping and reversing the planer table at the end of each stroke must be independent of the length of the stroke." This assumption on Mr. Barth's part was exactly where he erred and was presumably the reason why his theory and Mr. Meier's tests did not agree. The time of stopping and reversals varied materially with the length of stroke, as could be easily shown by tests, particularly in the case of the belt-driven planer. Further, this variation was noticeable in some cases up to a 10-ft. stroke; however, a 4- to 5-ft. stroke usually covered the noticeable variation. It would not only be necessary for Mr. Barth to substitute a variable in his equation for the different

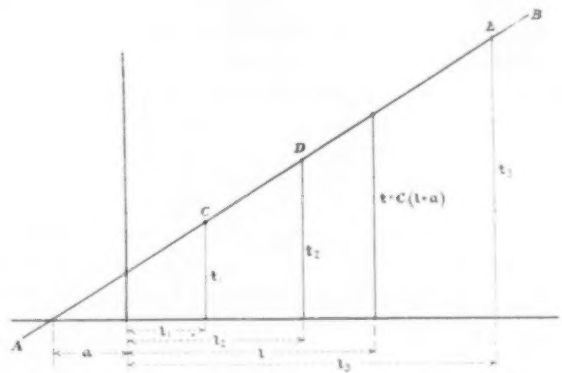


FIG. 1 METHOD OF DETERMINING VALUE OF a

lengths of stroke, but this variable in turn would necessarily have a different value when applied to drives of the single-belt-shifting type, the rocking-idler type, the double-belt-shifting, magnetic clutch, pneumatic clutch and direct-connected reversing motor drive. These in turn would all be affected by the different weights of the revolving parts, and in the case of the belt drives by the tension of the belts and by the time that it took for one belt to get from the loose to the tight pulley and the second belt from the tight to the loose pulley. There were, of course, many other elements that entered into the problem but the above were the main ones that would affect the constant a.

Mr. Barth's formula would be correct if V were a constant rate of speed instead of a variable rate of speed. An average velocity of V could not be used to determine a. Therefore, the formula would be good only in cases where the machine had reached full speed and then only under the conditions for which the actual value of a was obtained. If a were obtained under no-load conditions it would not apply when cutting if the shifting for the reverse occurred before the tool was out of the work. The changing value of V was even more noticeable when the machine was operating under load. Fig. 1 in Mr. Barth's discussion illustrated a very simple method of obtaining a provided it were an equation of the first degree. In reality, however, it was an equation of the second degree, which meant that a would have a continually changing value depending on the changing value of V and its effect on the stopping of the platen.

If Mr. Barth's Planer Time Slide Rule was based on the formula cited, it would have to be remodeled before any claim for accuracy could be made.

GENERAL SESSION, TUESDAY MORNING

THE Business Meeting on Tuesday morning was followed by a General Session, at which four papers were presented and discussed, as follows: Tests of Uniflow Steam Traction Engines, F. W. Marquis; Relation of Efficiency to Capacity in the Boiler Room, Victor B. Phillips; Radiation Error in Measuring Temperature of Gases, Henry Kreisinger and J. F. Barkley; and Development of Scientific Methods of Management in a Manufacturing Plant, Sanford E. Thompson, William O. Lichtner, Keppele Hall and Henry J. Guild.

A paper on Disk-Wheel Stress Determination, by S. H. Weaver, was also presented at this session by title.

PROFESSOR MARQUIS PRESENTS HIS PAPER

The first paper presented was that of Professor Marquis, giving the results of two series of tests of Baker uniflow steam-traction engines. The steam consumptions of these engines were compared with those representative of the ordinary counterflow type of engines, and the conclusion was reached that the uniflow engine tested, operating non-condensing with saturated steam, had a lower steam consumption than the compound counterflow engine under like conditions. Also, when operating non-condensing with superheated steam, it would have approximately the same steam consumption as a compound counterflow engine operating condensing on saturated steam.

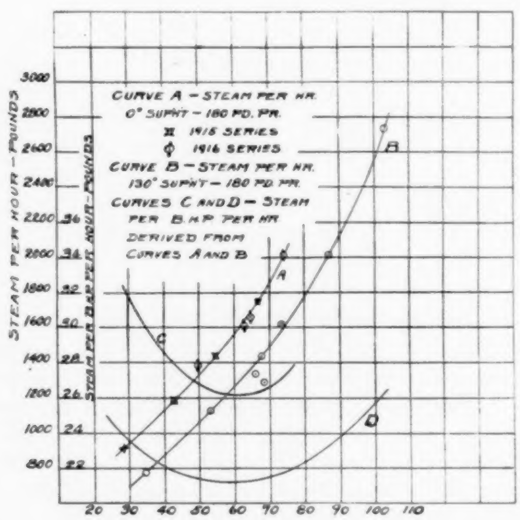


FIG. 1 REPLOT OF AUTHOR'S CURVES

Written discussions of this paper were contributed by J. E. Emswiler, George H. Barrus, L. V. Ludy and E. T. Adams. The paper was discussed orally by R. J. S. Pigott, C. H. Benjamin and A. G. Christie, and Professor Marquis replied to the discussion.

J. E. Emswiler, in a written discussion, considered that it would seem preferable, in most cases, to refer the steam consumption in the curves to b.hp. instead of i.hp., and especially so in these tests, where considerable discrepancy appeared if the f.hp. was plotted on b.hp. Such discrepancy must necessarily be blamed upon the i.hp. rather than upon the b.hp., since the latter was much more simply and easily determined in the tests.

The table for the 1916 series furnished some valuable information concerning the influence of superheat on steam consumption for a uniflow engine.

Test 7-180-4 was made with a load of 73.3 b.hp. and a superheat of 136 deg. Correcting the steam consumption to a load of 74 b.hp. gave a steam consumption per b.hp-hr. of 21.8. Test 16-180-4 at a load of 74 b.hp. gave a steam consumption per b.hp-hr. of 27.2 at 0 deg. superheat. This was a gain of 5.4 lb. for 136 deg. superheat, or 24.7 per cent, which was 18.2 per cent per 100 deg.

Again, test 10-180-3[2], at a load of 67.6 b.hp. and a superheat of 131 deg., showed a steam consumption of 21.3 lb. per b.hp-hr. Correcting in a similar manner to a load of 64.7 b.hp., the steam consumption became 21.6. Test 15-180-3, at a load of 64.7 b.hp. and 0 deg. superheat, gave a steam consumption of 25.6 lb. per b.hp-hr. This was a gain of 4.0 lb. for 131 deg. or 18.5 per cent, which was 14.2 per cent per 100 deg.

The average of the two examples was 16.2 per cent per 100 deg. of superheat, based on the steam consumption which accompanied the superheat.

Applying this correction factor to reduce the tests made with superheated steam to a common basis of superheat, say 130 deg., and plotting corrected steam per hour against b.hp., the curve *B* of Fig. 1 was obtained..

The curve *A* was obtained by plotting the steam per hour of the tests of both the 1915 and 1916 series, at 180 lb. pressure and 0 deg. superheat, against b.hp.

It was very instructive to plot the total steam per hour against the output, as was done in Fig. 1, for two reasons. In the first place, where a number of points were available, as was the case here, such curves served to distinguish those tests which were probably in error from some cause or other, from those which were accurate. It was evident from the curves of Fig. 1 that some discrepancy existed in connection with tests 6-180-3, 11-180-3[2], and 14-180-2.

In the second place, these curves were instructive as exhibiting a characteristic of the uniflow engine different from that of either a counterflow engine or a steam turbine. The steam-per-hour curve of the uniflow engine had a marked and continuous bend; while for the counterflow engine, or steam turbine, the curve was usually straight, at least for the greater part of its length.

The indicator diagrams in the paper showed a rise in the back pressure from the time the central exhaust ports were closed by the piston until the auxiliary exhaust port was closed. This was probably due to wiredrawing in the auxiliary exhaust port and represented some loss. Undoubtedly, from the standpoint of economy alone, the engine would be better without the auxiliary port, that is, operating on the strictly uniflow principle. However, it was presumable that the purpose of the additional port was to secure greater capacity, which it did by giving thicker diagrams than would be obtained without it.

George H. Barrus wrote that the tests reported were not tests of a "uniflow" engine, but they were tests of what might well be called a counterflow-uniflow engine, with the counterflow features in the lead.

There was nothing in the paper, so far as he could see, showing that the uniflow characteristics possessed by the Baker engine had anything to do with the superior economy reported. In fact, he could not see that these characteristics were sufficiently pronounced to produce any marked influence on the

results. The indicator diagrams were not materially different from those that would be given by any counterflow engine having the same valve gear and working under the same pressure and speed.

To justify the conclusion that the superior results given were due to any uniflow characteristic, a comparison should be made between the engine in question and an ordinary counterflow engine having the Baker valve gear, but the paper made no such comparison. All that the paper showed was the difference in economy between an engine having excellent steam distribution, such as that obtained by the Baker valve gear, and ordinary throttling slide-valve engines having defective steam distribution, which at best gave very poor economy.

If the title of the paper were changed to read Tests of Counterflow-Uniflow Steam Traction Engines, and the term "counterflow-uniflow" were substituted for "uniflow" throughout, the conclusions would be less liable to be misconstrued than they were in its present form.

L. V. Ludy reported the results of a series of tests on a Huber steam tractor a few years ago which gave some very interesting information in comparison with the tests reported in the paper.

The engine was fitted with a common D slide valve, which was unbalanced. The boiler was of the marine type, having a large flue extending throughout the entire length of the boiler, the back end of which served as a firebox. No superheater was provided. The method employed in carrying out the tests was exactly similar to that used by Mr. Marquis.

Table 1 gives the principal dimensions of the tractor, and Tables 2 and 3 the general results obtained.

In the results reported by Mr. Marquis, the maximum i.hp. in per cent of the normal rated hp. was unusually high. The results obtained from the 1915 engine were over 460 per cent and those from the 1916 engine about 600 per cent. Similar results reported by the writer gave this ratio of the greatest i.hp. to the normal rated hp. to be over 230 per cent, but in this case the engine was not operated at maximum load.

TABLE 1 PRINCIPAL DIMENSIONS OF HUBER TRACTOR

Boiler		Engine	
Number of tubes	18	Nominal horsepower	18
Outside diameter of shell, in.	41	Nominal speed, r.p.m.	220
Length of shell, in.	100	Diameter of cylinder, in.	9
Diameter of tubes, in.	3	Stroke, in.	11
Diameter of large flue at front, in.	24	Diameter of piston rod, in.	$1\frac{3}{8}$
Diameter of large flue at rear, in.	27	Diameter of flywheel, in.	36
Grate area, sq. ft.	6.59	Face of flywheel, in.	10
Total water heating surface, sq. ft.	173		

TABLE 2 SUMMARY OF ENGINE RESULTS

Length of test, min.	R.p.m.	Boiler pres., lb. per sq. in., gage	Average cut-off in per cent of stroke	I.hp.	Dry steam per i.hp., per hr., lb.
60	227.0	110.8	35.8	28.06	28.7
120	217.3	111.7	46.5	37.68	29.7
60	206.3	112.4	53.1	42.21	29.8

TABLE 3 SUMMARY OF BOILER RESULTS

Length of test, min.	Boiler pres., lb. per sq. in. gage	Coal fired per sq. ft. of grate surface per hr., lb.	Equiv. evap. per sq. ft. water-heating surface per hr., lb.	Equiv. evap. per lb. air-dry coal, lb.
60	110.8	14.3	5.58	10.25
120	111.7	24.5	7.75	8.30
60	112.4	27.1	8.72	8.44

E. T. Adams wrote that a moderate-power steam traction engine weighed at least 300 lb. per hp. It was therefore far too heavy for ordinary farm work and was really a portable power plant with its earning power practically limited to the threshing season. It was another example of a type of machine all too common on the farm which disintegrated from idleness rather than from use. The short earning and long rusting season was the vital disease affecting the traction engine. The remedy was a longer earning season, which might be secured by any change which would reduce the weight of these machines to a figure approaching 100 lb. per hp., thus making them available for plowing, disking, harrowing and seeding, as well as for threshing and other belt work. Increased economy could make this possible, but a minor increase would not be sufficient—it would have to be great enough to reduce greatly the size of the boiler, or even allow the use of a new type.

He thought that the A. D. Baker Company certainly deserved great credit for their endeavors to improve the economy of the farm tractor and had made a step in the right direction, because, although their coal consumption per b.hp-hr. in these tests was greater than that shown on single-cylinder tractors at the Canadian Industrial Exhibition tests in Winnipeg in July 1913, the steam consumption per i.hp-hr. was about 8 per cent. better when operating under the same conditions.

It seemed too bad, however, that they had not gone a step further. Their engine was undoubtedly a uniflow engine, in that it took steam at the end of the cylinder and exhausted at the center, but it did not use the thermal cycle which had made the engine commonly known as the uniflow engine so popular in Europe and, more recently, in this country.

The advantage of this European thermal cycle was illustrated by comparison of these tests of the Baker engine with tests made by Government licensed engineers on a portable engine of approximately the same horsepower and under about the same conditions, built by the Maschinenfabrik Badenia, of Weinheim. The Badenia engine had a normal brake horsepower of 120. The steam pressure was slightly lower and the superheat slightly higher than in the Baker engine. The Badenia engine showed an economy of 13.8 lb. of steam per i.hp-hr. and 1.83 lb. of coal per b.hp-hr. The Baker engine, therefore, required 38 per cent. more steam per i.hp-hr., and about 80 per cent. more coal per b.hp-hr.

As Mr. Marquis did not give the heat value of the coal used on the trials, it was impossible to get a close basis of comparison on the coal consumption. The coal used at Winnipeg had a heat value of 14,470 B.t.u. and at Badenia the heat value of the coal was 13,800 B.t.u. It would be noted that both the Winnipeg and Badenia trials were made by experts not in any way interested in the engines being tried.

R. J. S. Pigott said that in considering the curves of water rate and boiler efficiency he had found it extremely valuable to make use of the input and output, or Willans line, rather than the water-rate or efficiency curves.

In the first place, the Willans line for all throttle-governed engines, and for all turbines, up to the point where the relay valve opens, was substantially straight. For the automatic engine, the line was represented by an equation of the second

degree, and was curved upward more or less. The valuable feature was that as these Willans lines were either straight or only slightly curved, and the zero steam consumption always fell within reasonably-well-defined limits—say 15 to 20 per cent of full-load steam consumption, the direction of the curve could be very much more definitely settled, especially if the tests varied considerably from average. The water-rate curve could then be plotted from the Willans line.

One feature in Fig. 12 of the paper which seemed peculiar was the crossing of the lower boiler-pressure curves by the 175-lb. curve at low loads. This was very unusual, as in all cases he had seen, the raising of the boiler pressure improved the water rate and lowered the Willans line at all loads. The crossing of the water-rate curves indicated that the Willans line also crossed those at the lower pressures, giving a high no-load steam consumption, which was extraordinary. He would in general suspect an error, especially as the tests seemed short for accurate results by the feedwater method. Quite large errors were introduced by the capacity of the system and the impossibility of getting accurate indications of water content of the boilers by gage glasses; the shorter the test, the larger the effect of the error.

A further suggestion to the author was that the results be computed in thermal efficiency, Rankine-cycle efficiency ratio, and B.t.u. per hr., all referred to brake horsepower; the variations with i.hp. were of little value for a comparison with other types of prime mover.

The thermal efficiency was a basic measure of the real economy; so was B.t.u. per b.hp-hr. Water rates were not basic and varied with every set of steam conditions. The Rankine-cycle efficiency ratio was a valuable means of comparing the design of one engine with another, since it showed how well the engine made use of its steam range, although the thermal efficiencies might be very different. For instance, the efficiency ratio of a non-condensing compound engine might be as high as 75 or 80 per cent, and its thermal efficiency only 7 to 10 per cent; that of a condensing compound, 55 to 60 per cent, and the thermal efficiency 16 or 17 per cent; showing, as we now well knew, the extremely low efficiency ratios of low-pressure cylinders under condensing conditions.

These two efficiencies were the only ones of value in comparing steam results with internal-combustion-engine results. Messrs. Stott, Gorsuch and the speaker had advocated, in a Prime Mover Committee report for the A. I. E. E., 1915, that the use of water rates be abandoned as not basic, and that the above efficiencies be substituted.

A. G. Christie wrote that the paper gave some excellent data of the effect of superheat in a uniflow non-condensing engine. Considerable emphasis had been laid on the comparison of the uniflow and counterflow engines, and the curves in Fig. 14 showed comparative performance curves for several types of engines. It did not seem that any of these curves showed compound-condensing units with superheat.

In large power plants there was a tendency to increase both steam pressures and superheat. The tests in this paper showed the highly beneficial effect of adding superheat in a non-condensing unit. Engineers should therefore be interested in the performance of a small unit with high pressure, high superheat, reheating between cylinders, feedwater heating and condensing.

When the new laboratories of Johns Hopkins University were built, a 75-kw. Buckeyemobile was purchased from the Buckeye Engine Co., and direct-connected to a 50-kw. generator. This unit had been used to carry the summer light and power load of the University, and for test purposes by the students during the winter months. A portion of the test results was given in Table 1; the results were obtained by members of the senior mechanical-engineering class in a series of tests made last winter. The unit was not prepared especially for test and was operated as in general service. It was felt that the results represented very closely average operating conditions, though other previous tests had indicated lower coal consumptions at the various loads.

TABLE 1 PART OF RESULTS OF TESTS ON 75-KW. BUCKEYEMOBILE

Dry coal per i.hp-hr	2.32	1.57	1.40
Dry coal per kw-hr., lb.	4.06	2.55	2.27
B.t.u. in coal consumed per kw-hr.	57,453	34,540	31,280
Lb. of steam condensed per i.hp-hr.	10.80	10.5	9.63
Lb. of steam condensed per b.hp-hr.	12.65	11.32	11.0
Lb. of steam condensed per kw-hr.	18.94	17.0	15.62
Efficiency ratio of engine based on indicated horsepower, referred to adiabatic expansion, per cent	64.3	67.0	72.7
Efficiency of boiler alone, per cent	36.8	55.1	55.4
Efficiency of boiler, superheater, reheater and feedwater heater, per cent	43.2	64.6	66.3
Efficiency of complete plant from kilowatts at switchboard to heat in coal as fired, per cent	5.92	9.88	10.85

The unit had given very satisfactory service since it had been installed, and the operating and maintenance charges had been quite low. American engineers could well afford to give more attention to this type of unit with the rapidly increasing costs of fuel and labor.

PROFESSOR MARQUIS REPLIES

Professor Marquis, in replying, agreed with Professor Emsweiler that it was often preferable to refer steam-consumption curves to b.hp. instead of i.hp. In the present case the difference in the form of the curves would be very slight, and it was decided to use i.hp. in view of the fact that it proved more difficult to find results of tests of engines, with which it was desired to make comparisons, expressed with reference to b.hp.

In answer to Mr. Adams' question, the heat value of the coal used was approximately 13,700 B.t.u per pound, as fired.

In reply to Mr. Pigott's suggestion that the fact that the water rates were not in all cases lower, at all loads, with higher boiler pressure than with lower boiler pressure, indicated an error, and that the results might be adjusted with the aid of the Willans lines so as to eliminate this feature, he would like to call attention to the fact that if a Willans line was plotted for each boiler pressure of the saturated-steam runs, a very clearly defined tendency throughout for the higher-pressure lines to cross the lower-pressure ones at light loads would be evident. It was realized that the work doubtless contained some experimental errors, but it did not seem reasonable to infer that errors would occur in such a way as to consistently indicate the same thing. It did not therefore seem justifiable to adjust the results as suggested.

Moreover, it was evident that the cylinder condensation would be greater with high boiler pressures, due to the increased temperature ranges, than with lower ones. It did not seem unreasonable to infer that as the load became lighter and the cut-off earlier, a point would finally be reached where the loss due to increased cylinder condensation would overbalance the gain due to increased available energy, and the Willans lines cross, as actually indicated by the data presented.

He agreed entirely with Mr. Pigott as to the value of the use of the thermal efficiency, B.t.u per hour (or per minute), and the Rankine-cycle efficiency ratio, for comparison with other types of prime movers. The Rankine-cycle efficiency ratios referred to i.hp. would be found in column 12 of Table 2. The others were not presented in the paper.

PROFESSOR BENJAMIN TAKES THE CHAIR AND MR. PHILLIPS' PAPER IS PRESENTED

At this point, President Hollis appointed Vice-President Charles H. Benjamin to the chair, and Victor B. Phillips' paper on Relation of Efficiency to Capacity in the Boiler Room was presented by the Secretary in the absence of the author.

In this paper the author showed, by typical cost figures, that 90 per cent of the cost of producing steam was for fuel and fixed charges (including labor). He stated that these two charges were of almost equal importance, and that their reduction depended respectively on the attainment of efficiency and capacity. He then set about to establish the procedure for determining the relation of maximum efficiency at various loads to those variables of operation which the fireman might observe and over which he must exercise control. Test data on a B. & W. boiler, equipped with a Taylor stoker for a very wide range of operating conditions, were used to illustrate the procedure and to show the validity of the selection of variables.

The data applying to the furnace and boiler were shown respectively in charts having efficiency and capacity as coördinates, and the interrelation of the operating variables was indicated, as on steam charts, by lines of constant values. These two charts were then combined into a single chart having as coördinates overall efficiency and capacity of the steam-generating plant, and which graphically represented the two objects to be sought—efficiency and capacity—in terms of the variables of operation through the manipulation of which they might be obtained. The striking test results shown in the furnace-operation chart were discussed in an appendix, which also gave details of the procedure employed.

This paper was discussed orally by William Kent, L. C. Bowes, W. F. M. Goss and J. M. Spitzglass, and written discussions were contributed by R. C. Carpenter, Maxwell Alpern, George H. Barrus, Bryant Bannister, and N. G. Reinicker.

William Kent said that about twenty-five years ago he stated before the Society that the relation of efficiency to capacity of a boiler was not expressed by any curve or formula, but by a field the upper limit of which represented the results that could be obtained under the best possible conditions. The width of this field was very great, and was a measure of our ignorance concerning how to get the best conditions.

His studies for forty years had been directed toward helping to narrow the limits of this field, which had now been done to the extent that the action of a boiler could be predicted to within 5 per cent or less when the duty was known.

In regard to the thickness of the fire, some thirty years ago he made a 24-hr. test with pit coal and with every facility for making a good observation. The test was divided into 8-hr. periods and the first period was run with thin fires, the second with medium fires, and the third with thick fires. The best results were obtained with thin fires and with thick fires, and the worst with medium fires. From these data he did not think anyone could draw any conclusion.

In 1895 he made a series of 75 tests on a Babcock & Wilcox boiler, with a great many variable conditions. Some of these tests run with thick fires and strong draft gave results within $1\frac{1}{2}$ per cent of those obtained with thin fires and moderate draft, again leading to no conclusion as to the merits of thin fires and thick fires.

In regard to carbon monoxide, he had a series of apparatus arranged so that gas samples could be taken from half way through the boiler tubes every minute. The first minute gave no oxygen and 7 per cent CO_2; the second minute 4 per cent CO_2 and a trace of oxygen, and at the end of five minutes 7 per cent free oxygen and no carbon monoxide. This showed the tremendous variation in conditions that could exist inside of five minutes.

This test led to no conclusion as to the CO_2 except that it was extremely variable. Results of 75 tests were plotted against every variable, and such conclusions drawn as could be.

What conclusions he had obtained in nearly forty years of making boiler tests were to be found in his Steam Boiler Economy. A little differential calculus had been used in dealing with the problem; but it seemed to him that all investigators had entirely ignored that study. He hoped Mr. Phillips would check his results against the things given in that publication and see if they did not reach more definite conclusions than in the paper.

L. C. Bowes thought the paper pointed out one very essential thing: that the maximum efficiency was gained at about 25 per cent overload. There seemed to be a great tendency at present for stoker manufacturers to recommend stokers to fire above the rated capacity of the boiler, for which tendency central-station practice had probably been responsible.

With a stoker and boiler giving a high overload capacity, with a 12-hr. peak, the loss in the boiler due to high overload capacity in order to operate the stoker at an efficient point would exceed the loss due to maintenance charges on additional boiler capacity, with stokers somewhere near consistent with the rating of the boiler. This point was very essential where there was a standing load on a 10-, 12- or 24-hr. peak.

In central-station practice, where there was only a three- or four- or sometimes a single-hour peak, high boiler capacity of course was required, but he would like to see some curves showing in some way the relation between the fixed charges and fuel cost dependent on varying relations between the stoker capacity and the boiler capacity.

W. F. M. Goss said that in our efforts to increase efficiency we were likely to lose sight of a matter of considerable present-day importance to which mechanical engineers should give due attention. He referred to the increase in the pollution of the atmosphere which resulted when boilers were driven to higher capacities.

The record of locomotive-boiler performance had long since disclosed the fact that stack losses in the form of solid particles of fuel constituted a most important factor in their effect on boiler efficiency. We knew that as we increased the capacity of a locomotive boiler we also increased the percentage of solid fuel passing up the stack. For locomotives in which a third and sometimes a half hp. was secured per square foot of heating surface, the relation of solids (fuel and ash) passing up the stack to rate of combustion was known for a considerable number of different fuels. There was very little similar information applying to boilers in power plants, notwithstanding the fact that we were constantly increasing the rates of combustion in such plants, and by so doing bringing stationary practice to a point where it overlapped a portion of the field covered by locomotive service.

Mechanical engineers were naturally interested in that

aspect of this question which affected boiler efficiency. His present purpose was to urge the importance of their being interested in that aspect of the question which affected the purity of the atmosphere.

J. M. Spitzglass said that he would not hesitate to say that the relation between operating efficiency and capacity was *the* most important factor in the boiler room, also in the engine room and, in fact, in every unit of a plant.

The author had two objects to accomplish in his paper: to demonstrate that the boiler operation should be studied systematically in relation to the two fundamental variables, *efficiency* and *capacity*, and to actually study this relation. While he succeeded in accomplishing the first object, he utterly failed in the second.

He regarded the author's treatment of the furnace factors as very interesting, indeed. The combination of an air meter and draft gage, assisted by the analysis of flue gases and readings of temperatures, would answer very well if there were always some reliable person whose duty it would be to take these various readings.

When it came to the boiler, however, after demonstrating that the relation between efficiency and capacity was the most important factor in operation, the author did not suggest the direct method of indicating or determining the capacity of the boiler at all times, which was by a steam meter. He merely contented himself with saying that the factors governing furnace operation should also govern boiler operation.

It was not to be denied that some idea of the capacity could be obtained from the conditions of the furnace and measurement of air supply when six extra men, trained for the purpose as was the case in the paper, were present to observe and manipulate the readings of the various devices operated during the test. But, how many firemen would be found who were able to observe air velocities, draft-gage readings, gas analyses and flue-gas temperatures; and if they were, how many could interpret them? Many places would be found where most of these instruments were present but were seldom followed by the firemen, but Mr. Spitzglass had yet to see the place where a boiler-steam meter was installed that it was not watched by the firemen the same as the pressure gage or the time clock.

Some might object that the steam-flow meter was not 100 per cent accurate. It was not; neither were any of the attachments to the furnace, as far as he knew. The author had demonstrated that under a given set of conditions, differential pressure readings would repeat themselves for the same quantities they represented. It stood to reason that the flow meter, which was merely the index of the differential pressure corresponding to the flow, would repeat itself for the same flow, and by weighing the feedwater for only a short period, the absolute calibration might be readily obtained for each boiler or line.

But this calibration, or even the whole accuracy, was not the question of the boiler steam meter at all. The main object was having something definite and comparatively accurate striking the fireman's eye at all times—something that he could easily understand without any interpretation or calculation.

The fireman had a problem which we seldom realized. With no steam meter on the line, he did not know what the boiler was actually producing, he merely guessed at it. The demand for steam was out of his control and knowledge. Suppose he learned that by following a certain operation he kept up the pressure at a given time, how was he to know what the actual demand was at that time, or, as the author put it, what the capacity of the boiler was at that time?

We could not expect a fireman to operate efficiently from a set of charts drawn up after a boiler test. But, when he saw that by performing a certain operation he caused the steam-meter hand to move to the high-capacity side, he visualized the result and would surely repeat the same operation, knowing it effected better and easier work in general.

R. C. Carpenter thought that the paper represented the first series of investigations so conducted as to determine the results produced by greatly varying the coal consumption.

It was a matter of regret that in the tests the limit of air supply rather than the heating surface proved insufficient for complete combustion at the highest limits of coal consumption. Lines 13 and 15 of Table 2 gave information as to the drop in efficiency following the increase in the combustion of coal as indicated on line 3. The determination of the weight of air employed for the combustion of the fuel afforded an opportunity for noting the effect due to the regulation of the air supply, which important matter had seldom been given consideration in boiler tests. The particular air meter employed was of interest, as were also the scientific results given as proper conclusions drawn from the investigation.

The records of the investigation would be of great value in determining the limit of capacity of steam boilers, which was now under consideration in every recent construction. Obviously as the limit of capacity for a given efficiency was increased, the overhead and operating costs were reduced.

M. Alpern, in pointing out some of the operating faults of the tests, particularly as they affected the performance of the Taylor stoker used, spoke as follows:

"Theoretically, the Taylor stoker consists of an inclined retort, throughout which the air pressure is supplied under constant pressure and through constant areas of air discharge; an auxiliary grate surface at the rear of the inclined retort for the purpose of burning out the devolatilized fuel, and a substantially imperforate dump plate on which the residue can remain for a relatively long period, for the purpose of further reducing the carbon in the refuse and discharging the refuse into an ashpit. In operation it is intended that a maximum fuel-burning effect shall take place in the space occupied by the mouth of the retort and that the feed of the fuel in the retort shall be so regulated by the adjustable feeding mechanism that the fuel will rise from the mouth of the retort uniformly throughout. Such of the fuel as remains unburned together with the refuse feeds over the auxiliary grate at the rear, which grate has a hand-regulated air supply. This air supply can be regulated from zero to a maximum opening.

"Technical operators are instructed in the operation of the Taylor stoker by observation of the fire only. When properly adjusted and properly operated, the fire will go through a regular cycle. The mixture of fuel and ash will be deposited on the dump plate until the plate is covered to a depth of possibly 12 to 15 in. While the stoker continues to operate, the material is deposited on the dump plate only as the material already there wastes away by the process of combustion and provides room for it. Accordingly, at the end of a period of 3 or 4 hours, the material on the dump plate takes on a dead and, to some extent, blackened appearance. This indicates that the time has arrived to dump. At what are normally known as low rates of combustion, that is, rates of combustion below 500 lb. per retort per hour, no air is used on the auxiliary grate, that is, the damper is closed. A

small amount of air may escape through leakage. Except just prior to the dumping period, for an interval of perhaps 15 minutes, the damper is open (sometimes wide open, sometimes only part way open). It is only at rates higher than 500 lb. per retort that there is any opening of the damper through the period of operation between dumps. If the stoker does not go through the regular cycle and produce a

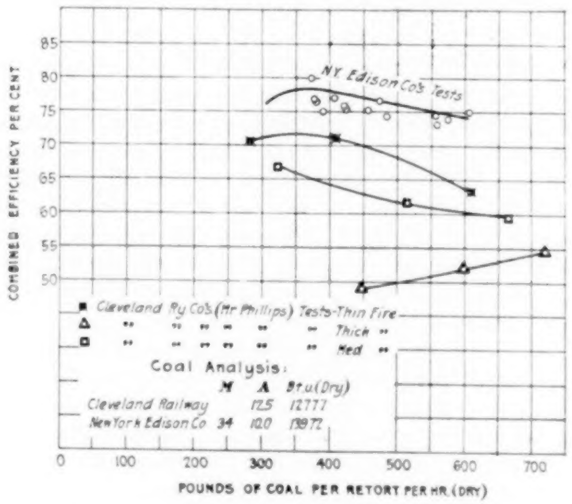


FIG. 1 COMPARISON OF AUTHOR'S AND NEW YORK EDISON COMPANY'S EFFICIENCIES FOR TAYLOR STOKERS

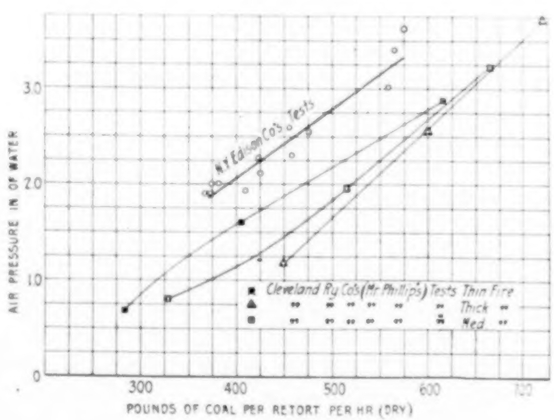


FIG. 2 COMPARISON OF AIR PRESSURES

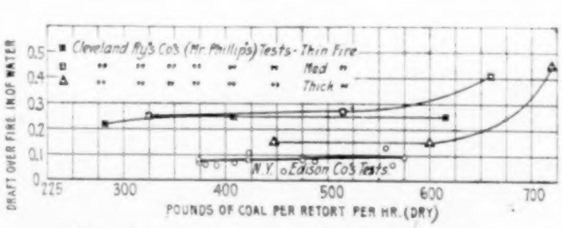


FIG. 3 COMPARISON OF DRAFT OVER FIRE

burned-out ash at the end of a 3- or 4-hr. period, no better indication need be had that one of two things is wrong. Either insufficient air is being supplied to the fuel emerging from the retort, or the feed of the lower ram is not adjusted properly. These adjustments are very simple to make. It is apparent in the tests reported by Mr. Phillips that the air supplied to the fuel over the retort was insufficient, the damper to the extension grate was wide open all the time, and it would also appear that the fuel bed was not properly adjusted.

"The accompanying curves will clearly indicate the trouble In Fig. 1 are plotted first the efficiencies obtained by Mr. Phillips with light, medium and heavy fuel beds. In the same figure are shown the efficiencies obtained on the Taylor stoker of exactly similar design with the same ratio of heating

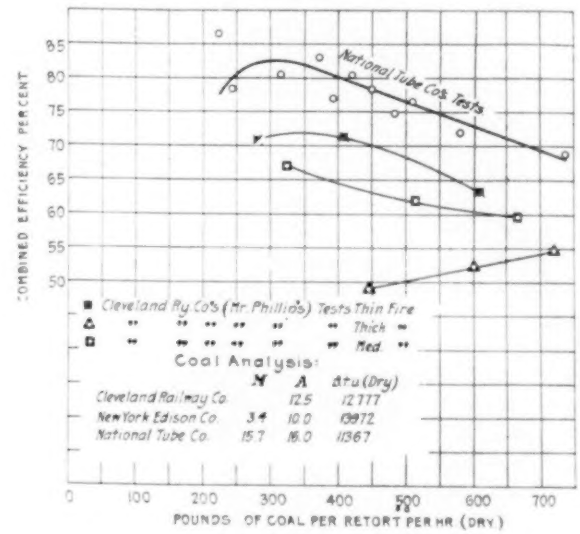


FIG. 4 COMPARISON OF AUTHOR'S AND NATIONAL TUBE COMPANY'S EFFICIENCIES FOR TAYLOR STOKERS

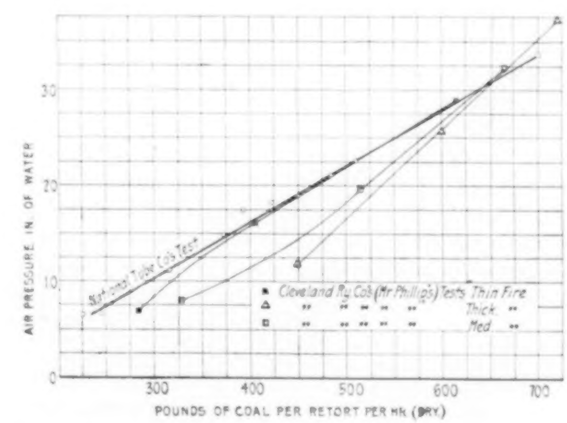


FIG. 5 COMPARISON OF AIR PRESSURES

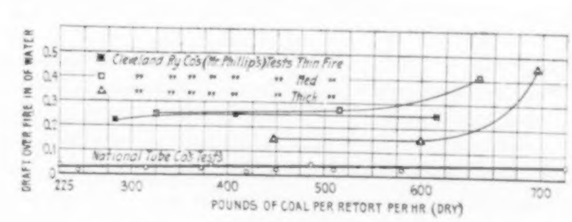


FIG. 6 COMPARISON OF DRAFT OVER FIRE

surface to grate surface, on tests run at the New York Edison Company. The coal used in the latter tests was somewhat better than the coal used during the Cleveland Railway tests.

"In Fig. 2 are indicated the air-pressure curves. The air pressure in both the New York Edison tests and the Cleveland Railway tests represent the difference in pressure between the windbox of the stoker and the furnace over the

fuel bed. It will be noted that the New York Edison tests show very much higher pressure at corresponding rates of fuel-burning.

"Fig. 3 shows the draft over the fire, in the case of the New York Edison tests and the Cleveland Railway tests. The draft over the fire in the latter tests was materially higher, as, of course, was the draft throughout the boiler, causing a larger loss from infiltration of air.

"Fig. 4 illustrates tests run on a Taylor stoker of similar design with a similar ratio of heating surface to grate surface at the National Tube Company, Kewanee. In this case, a much lower grade of fuel was burned than that reported in Mr. Phillips's tests.

"Fig. 5 shows the relative air pressures between the National Tube Company tests and the Cleveland Railway tests. In the case of these tests, the air-pressure curves are much closer together, owing to the fact that the actual combustible burned with Illinois coal was much less per pound of dry coal than was true of the coal burned at the Cleveland Railway tests.

"Fig. 6 illustrates the draft over the fire.

"Fig. 2 also shows the air pressures used by Mr. Phillips at corresponding rates of combustion per pound dry coal. It will be noted that with the heaviest fuel bed the lowest air pressures were employed, and with the thinnest fuel bed the highest air pressures were employed, which is just contrary to what is necessary for good operation. The heavy fuel-bed condition was an unnatural one for the Taylor stoker, and existed only because the fire was starved for lack of air."

George H. Barrus wrote that the paper stated that the "fuel bed was kept uniform and constant in thickness by very close and frequent observation on the part of three different men, all experienced firemen." From this it was evident that "the flying start and stop" was the method pursued in beginning and ending the tests. Everyone who had had experience with the operation of Taylor stokers realized that it was almost impossible for an observer, whether an experienced fireman or expert, to judge of the exact condition of the fuel bed in the regular operation of such a stoker. It was therefore well-nigh impossible to make a flying start and stop with a stoker of this kind and be assured that the condition was anywhere near the same at the beginning as at the end of a test.

Realizing this, the Power Test Committee of the Society had prescribed certain rules regarding the duration of stoker-fired tests and the method to be employed in starting and stopping them.

In regard to duration, he quoted from Par. 45 of the Power Test Report, as follows:

> In the case of a boiler using a mechanical stoker, the duration, where practicable, should be at least 24 hours. If the stoker is of a type that permits the quantity and condition of the fuel bed at beginning and end of the test to be accurately estimated, the duration may be reduced to 10 hours, or such time as may be required, to burn the above noted total of 250 lb. per sq. ft.
>
> In commercial tests where the service requires continuous operation night and day, with frequent shifts of firemen, the duration of the test, whether the boilers are hand-fired or stoker-fired, should be at least 24 hours. Likewise in commercial tests, either of a single boiler or of a plant of several boilers, which operate regularly a certain number of hours and during the balance of the day the fires are banked, the duration should not be less than 24 hours.

There was nothing in Par. 45 that permitted a test of the Taylor type of stoker to be less than 24 hours in duration, in a plant like the one in question operating for 24 hours per day.

Mr. Barrus also called attention to Par. 48 of the Power Test Code, which related to the starting and stopping of a stoker test, in order to show that there was nothing in the requirements that countenanced the flying start and stop, which appeared to have been followed in the tests reported in the paper.

Bryant Bannister[1] wrote that the author had invited discussion which should be quite beneficial to boiler-plant designers. It went without argument that the designer should attempt to provide the maximum of capacity with a given investment, without corresponding contingent losses. With the data available pertaining to heat transmission through setting walls, boiler tubes, etc., we could safely design a boiler plant for what might be termed "intensive steam production."

Since the two greatest sources of heat loss in steam production originated in the boiler furnace and through the boiler proper, we could expect the greatest interference with the design for maximum steam production either in the stoker or the boiler proper. It was possible to meet the first interference by the use of stoker equipment which improved the furnace efficiency as the rate of fuel consumption was increased. One make of stoker had this important characteristic up to a burning rate of about 1000 lb. of coal per retort per hour, and possibly further. Referring to Fig. 2 in the author's paper, it would be noted that a curve connecting the points of maximum furnace efficiency had an upward trend, rising from 68 per cent at a furnace output of 555 boiler hp. to 76 per cent at 1055 boiler hp. output. It then became the duty of the boiler unit to absorb the heat evolved without unduly high exit-gas temperatures.

The second interference pertaining to heat transfer into the boiler had been very admirably treated by Messrs. Kreisinger, Ray and Barkley in Bulletin 18, and Technical Paper 114 of the Bureau of Mines. These papers were both splendid arguments for greater capacity from a given boiler heating surface.

Presuming commercially clean tube surfaces, both inside and out, it followed that we must go further than was usually considered good practice toward providing for a long gas passage in contact with tube surface, also toward increasing the gas velocity. Just where we should stop with the boiler surface proper and introduce economizer surface must, of course, be governed by local conditions, costs, etc., but the writer believed that such economizer surface could be provided adjacent to the boiler, preferably above, with tubes of suitable size and so arranged that high gas velocity was obtained, in many cases with a single pass for gas flow.

Because large boiler units lent themselves so well to the above scheme they should be given consideration as an essential feature in the design.

If the principle of "intensive steam production" was adhered to in both design and operation, the result would be minimum investment per unit of steam produced, while the cost of operation, including fuel, labor and material for repairs and maintenance, etc., would not be increased much over similar costs for normal steam production.

The tendency toward the proposed design was apparent in central-station construction, and the writer hoped that it would be appreciated and followed for the average industrial boiler plant of the future.

[1] National Tube Company, Pittsburgh, Pa.

N. G. Reinicker[1], while admitting that the author was correct in his statements of the importance of efficiency and capacity, considered that any conclusions regarding these items, based upon the tests reported, would be entirely out of accord with results which could be and were being obtained with similar equipment and coal throughout the country.

The fact that the runs were of only eight hours' duration was sufficient alone to discard all the tests. With any furnace having a large amount of fuel on the grate, as was the case with the underfeed stoker, it was possible in an 8-hr. test to get any efficiency desired. Twenty-four hours was the minimum time in which such runs should be made.

In every test reported there was a large deficiency of air. The furnace was apparently used as a gas producer, with secondary combustion in some of the passes, as shown by the exit gas temperatures and CO loss, and undoubtedly considerable smoke came from the stack.

The drafts for all runs showed no consistency, especially furnace draft, which was much higher than necessary. The air pressure under the tuyeres should have been from ¼ in. to 1 in. higher to supply the required air to burn the coal.

Assuming the tests were greater in number, more carefully run, and representative of the equipment and coal used, the conclusions reached from an analysis of the Combined Boiler-Unit Operation Chart would be of no value to an operating man. The experience of trying to pick from a chart the air pressure required for any rate of burning coal was like the experience gained by a number of engineers who bought tachometers for their stokers and had a second scale added showing the air pressure the fireman should carry for that stoker speed. They found the second scale of no value.

The author failed to mention the most important item controlling capacity and efficiency in an underfeed-stoker furnace, and that was the temperature at which the ash fused. With a coal causing considerable clinker, air quantity would not affect capacity unless the air could be made to distribute through the fuel bed, and not through holes in the fire. Clinker would cause holes and would limit capacity and reduce efficiency.

Less attention should be paid to convection and radiation, the losses from these items being such a small part of the total losses in a boiler-and-furnace heat balance, and much more attention paid to losses from combustible in the ash and from CO, which losses together, using the equipment and coal of these tests, should not be more than 10 per cent of the total heat supplied.

C. F. Hirschfeld wrote that there were three distinct subjects treated in the paper and they should be recognized as such and separately considered. These subjects were:

1 A discussion of the combustion of solid fuel on chain grates and on underfeed stokers, with a suggestion as to the essential variables and means for their indication and control

2 A discussion of the factors influencing the efficiency of the boiling vessel

3 A demonstration of the fact that the efficiency of the furnace as a heat liberator and the efficiency of the boiling vessel as a heat absorber were interrelated, and that there was one set of furnace conditions at each load which gave the best efficiency for the combination.

With reference to the discussion of combustion and its control, there had been a very general recognition recently of the fact that the burning of coal under steam boilers could be reduced to a fairly exact procedure if the proper indicating instruments were supplied. It had also been recognized that if the best results were to be obtained it would not be sufficient to supply only instruments by means of which the operator might measure the degree of success achieved. It was also necessary to furnish instruments which would measure for the operator the values of the various variables which combined to give the indicated result in order that he might be able to change the values of these variables wisely and methodically for the purpose of obtaining the highest possible effect.

The author proposed thickness of fuel bed and pressure drop through the fuel bed as the important controlling variables. He further proposed an inferential method of determining fuel-bed thickness, namely, the measurement of the quantity of air passing through the fuel bed in a given time and the pressure drop required to force this quantity of air through the bed.

If the operation were to be conducted by men of such mental caliber that they could not be educated beyond the point required to enable them to keep the indications of two instruments at prescribed points, it would be admitted that the author's suggested method of furnace control would probably give as satisfactory average results as could be obtained under those conditions. However, it might be pointed out that it represented little if any advance over the automatic interlock between fan speed and stoker speed, originally a characteristic part of a Taylor-stoker installation.

If the operation were to be conducted by men of such mental caliber that they could be educated to a true appreciation of the meaning of all, or most, of the variables which interacted to give a certain result in the furnace, then the proposed method would be decidedly inadequate and imperfect, particularly as applied to underfeed stokers. In this case the pressure drop through the bed, taken in conjunction with the quantity of air passing, would be a true indication of the average thickness of the fuel bed if that bed were always formed of coal of the same kind and size, if the damper settings on extension grates and other controllable points were always the same and if the character of the fire as influenced by its past history were always the same. Unfortunately, all of these variables had marked effects.

To take extreme illustrations, it might be assumed, for one case, that an operator had managed to pile up a thick fire at the top of the stoker and had burned it very thin toward the toe; and for another case, that he had forwarded the fuel more rapidly than he should have, so that he had a thin fuel bed near the top of the stoker and a thick fuel bed near the toe. In each case he would have obtained and observed some definite pressure drop which would have corresponded to perfect fires of certain definite thicknesses, and yet his fire would have been far from perfect. Or again, it might be assumed that the character of the coal and its method of combustion were such that there was serious clinkering in spots, with burning through in others. Such a condition would give a pressure drop corresponding to some definite thickness of perfect fuel bed, and yet the actual conditions would be far different.

After all was said and done, optical inspection of the fire and a good knowledge of its past history were required if the best results were to be obtained. The combination of such inspection and such knowledge with the readings of properly chosen instruments, by an operator educated to the point where he could appreciate the true significance of all facts and indications, was the most promising method of obtaining high efficiencies.

The firing methods in use in the boiler rooms of The Detroit

[1] New York Edison Company, New York.

Edison Company practically included the features which the author proposed, but others had been added and it was recognized that more must be added before the best control now in sight could be attained. At the plants of this company it was customary to maintain a certain definite draft at a chosen point above the fire and to vary the under-fire pressure to suit conditions. This arrangement gave the fireman a measure of the pressure drop through the fire. The quantity of air used was not measured in conventional units but in terms of blower speed and resistance through the bed, which was just as good a combination measurement, so far as the operation was concerned.

No attempt to reduce coördinated readings to chart form had been made because the constant effort of the engineers had been devoted to the education of the men to such a point that they could reason from the known condition of their fire and the readings of their instruments, instead of going it blind on the basis of charts which at best could represent only average conditions.

In these plants it had been found advisable to supply instruments for indicating stoker speed, carbon-dioxide content of flue gases, temperature of flue gases and boiler output, as well as the values mentioned above, and it had also been found advisable to supply numerous dampers for controlling the distribution of air to the various parts of the fire. With all of these tools in the hands of thinking operators, remarkably good results were obtained and maintained.

The author of the paper had performed a real service in emphasizing, in what had been previously referred to as the second and third parts of his paper, the known fact that the best overall efficiency of the unit was really the product of the efficiencies of its two component parts and that the best combined efficiency might not correspond to the highest efficiency of furnace or of boiler. There were astoundingly few figures available by means of which one might even approximately determine values of this sort, and it would be of great value to the industry if typical units could be tested over wide ranges with respect to all essential variables in about the same way as had been the unit tested by the author of the paper.

Unfortunately for the type of control advocated, and for the worth of the data submitted, the tests recorded in the paper did not seem to represent good furnace practice. The so-called overall efficiencies were low, even for modern operating conditions under variable loads, and were correspondingly lower in comparison with what would be expected under test conditions.

Moreover, when these efficiencies were considered in conjunction with the stated thickness of fire and the under-fire pressure, one was driven to the conclusion that what the author called a thin fire must really be thick and what he called a medium fire must be very thick, or else that some other variable of great importance must have been neglected. The flue-gas temperatures and carbon in refuse also appeared to be abnormally high for the various loads and conditions to which they corresponded.

MR. KREISINGER PRESENTS PAPER BY HIMSELF AND MR. BARKLEY

With President Hollis again in the chair, a paper entitled Radiation Error in Measuring Temperature of Gases, by Henry Kreisinger and J. F. Barkley, was then presented by the former.

The purport of this paper was that in measuring a temperature of a stream of hot gases surrounded by colder or hotter surfaces, heat radiates to or from the measuring instrument, making it read high or low, and the difference between the true temperature of the gases and that indicated by the instrument is called the radiation error.

The paper enumerated the factors with which this error varies, and to show the magnitude of the effects of some of them, gave results of a series of measurements made with thermocouples placed at different points along the paths of gases flowing through water-tube boilers, citing one instance where the error under certain conditions could be as much as 320 deg. cent.

A written discussion of this paper was contributed by E. A. Fessenden and R. B. Fehr, who wrote that the paper was of decided value in calling attention to a source of error that had heretofore been almost universally neglected. It was, of course, obvious that there was no radiation error where the temperature-measuring device was completely surrounded by surfaces at the same temperature as the medium whose temperature was being measured. Many experiments concerning gas temperatures in steam boilers, however, had failed to be of material value because the conclusions had been based upon direct temperature measurements of gases surrounded by comparatively cool surfaces.

It was stated in the paper that "very likely it is the extent of the surface of the hot junction which determines the magnitude of the radiation error." It was not clear, however, just what was meant by "the surface of the hot junction." Apparently the authors had taken this to mean the surface of a cylinder whose diameter was that of the junction, which in their case was made the same as the diameter of the elements. No mention was made, however, of the length of this cylinder, and the surfaces had been assumed to be proportional to the diameters. The effects of conduction along the elements from the couple ought to be discussed along with these radiation effects. It would seem, therefore, that the length of the cylindrical surface as well as the diameter should be considered on account of the effect of the conduction of heat to or from the hot junction. Three cases might be noted:

1 Where the couple leads were surrounded by material of the same temperature as the junction (as, for example, in the authors' experiments in which the couple leads were perpendicular to the direction of flow of a large volume of gases) the temperature of the leads was the same as that of the junction and no conduction effects were produced.

2 Where the couple leads were surrounded by material cooler than at the junction, the temperature of the leads would be lower than that of the junction so that heat would be conducted away from the junction by the leads. The amount of heat carried away from the junction in this manner, and consequently the lowering of the junction temperature, would depend upon the material of the leads, their cross-section, and the temperature gradient. An example of this condition was the case where the couple was inserted in a boiler tube in which the gases were flowing parallel to the couple leads and with the hot junction pointing upstream.

3 This case was similar to the second one except that the material surrounding the leads was hotter than at the junction, as when a thermocouple in a boiler tube pointed downstream. Here heat would flow toward the junction and tend to raise its temperature.

In the second case radiation to cooler surrounding surfaces and conduction along the elements both tended to make the

reading lower than the actual temperature of the substance, while in the third case conduction tended to raise the reading and radiation to lower it.

It was to be hoped that this paper might be considered as preliminary, and that the authors would continue these investigations and at a later date give definite and quantitative information as to the effects of radiation and conduction upon thermocouples, taking into account:

a Size and material of couple elements
b Size of lead at hot junction
c Length of exposed elements
d Size and kind of protecting tubes
e Application of Stefan-Boltzmann law
f Temperature gradient in the substance surrounding the leads.

MR. KREISINGER'S REPLY TO THE DISCUSSION

Henry Kreisinger, in his written closure, replied to the suggestion of Messrs. Fessenden and Fehr that the effects of conduction along the elements of the couples should have been discussed along with radiation effects, saying that this point was simply a question of how complete a treatise on the errors in measuring the temperature of gases one wished to write. The authors had decided to treat the radiation error, and had limited themselves in the present paper to this error as far as practicable. The thermocouples they had used in their experimental work were so constructed and the experiments so planned that the conduction effect was eliminated.

In all cases the leads from the hot junctions were sufficiently long as compared to their cross-section that any lowering of the temperature of the hot junctions by heat conduction along these leads was prevented. With the smallest couples the leads were 0.008 in. diameter for a length of ½ in., and then 0.025 in. diameter for a length of ¾ in. The cross-sections of these leads were too small for heat to be conducted along their lengths. Within the lengths of these leads the temperature gradient of the gases could be but very small. This construction of the couples was very well adapted to the measuring of temperature of gases within a boiler tube, as cited in the second case noted by Messrs. Fessenden and Fehr.

The large copper-constantan couples were made of copper tubing ½ in. in diameter, having a wall 0.052 in. thick. This tube which formed the leads was immersed in the gases for a length of about four feet. The temperature gradient for a large part of this length was very small, so that it was not necessary to consider the conduction of heat from the hot junction along the leads. The same could be said as to conduction of heat along the protecting silica tube of the large platinum thermocouples.

The surface of the hot junction of the small couples might be considered as cylinder, but in the large couple this surface was partly a sphere and partly a cylinder. Just how much of each should be considered was difficult to determine. The particular construction of the large couple was adopted because it was simple and inexpensive, and mainly because commercial thermocouples were of a similar design.

It should be added that the hot junctions of all the couples were placed in the center of the stream of gases and pulled out by steps, temperature readings being taken every two inches to determine temperature gradient of gases. The results of this part of the experiments were given in detail in the Bureau of Mines publication on Measuring the Temperature of Gases inside of Boiler Settings.

The fact that the radiation error became smaller as the diameter of the couple decreased, might be explained without going into too detailed refinements in the following manner: The couple received heat from the gases by convection and gave it off by radiation. When the temperature of the couple was constant the quantity of heat received by the couple was equal to the quantity given off by radiation. The convection did not impart the heat directly to the metal of the couple but to the outside surface of a gas film adhering to the solid. Through this gas film the heat passed by conduction. On the other hand, the heat was radiated directly from the surface of the metal through the layer of gas.

The quantity of heat that was received or given off by the couple depended on temperature difference and the extent of the surface receiving or giving off the heat. Since the thickness δ of the gas film remained practically constant no matter what the diameter of the couple was, it was apparent that as the diameter of the couple decreased the heat-radiating surface decreased faster than the heat-receiving surface of the gas film. The effect of the unequal decrease of the two surfaces was especially marked when the diameter of the couple became less than the thickness of the gas film. As the zero diameter of the couple was approached the ratio of the heat-receiving surface to the radiating surface became infinitely large, the radiation ceased and the temperature of the couple became the same as the temperature of the gases.

Following this course of reasoning, it was possible to apply the Stefan-Boltzmann radiation law and the law governing the heat transmission by convection and derive an equation expressing the relation between the diameter of a couple and the true temperature of the gases when the temperature of the surrounding surfaces and the temperature of the couple were given. The temperature of the couple was read when the quantity of heat received by convection was equal to the quantity given off by radiation; or, if Hc designated the heat received, and Hr the heat given off,

$$Hc = Hr \quad [1]$$

Let T = the temperature of the stream of gases

T_3 = the temperature of the outside surface of the gas film adhering to the couple

T_1 = the temperature of the couple

T_2 = the average temperature of the surfaces surrounding the stream of gases, expressing all temperature in absolute units

S = the surface of the gas film receiving heat by convection

S_1 = the surface of the metal giving off heat by radiation.

Then from the law of heat transmission by convection,

$$Hc = K(T - T_3)S \quad [2]$$

Inasmuch as with a set of any number of couples the velocity and density of gases were the same for all couples, these two factors were embodied in the constant K. And from the Stefan-Boltzmann law,

$$Hr = r(T_1^4 - T_2^4)S_1 \quad [3]$$

From equation [1],

$$K(T - T_3)S = r(T_1^4 - T_2^4)S_1 \quad [4]$$

The same quantity of heat that was imparted to a unit of the outside surface of the gas film by convection, passed through the film by conduction and might be expressed by the simple equation:

$$H = C\ (T_3 - T_1) \quad [5]$$

therefore $C\ (T_3 - T_1) = K\ (T - T_3)$ [6]

or $T_3 - T_1 = (K/C)\ (T - T_3)$.

But $T - T_1 = (T - T_3) + (T_3 - T_1)$ [7]

or $T - T_1 = (T - T_3) + (K/C)(T - T_3) = k(T - T_3)$.

Therefore, for the whole couple,

$$Hc = c\,(T - T_1)S \;\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots [8]$$

Taking D as the diameter of the couple, then:

$$S \propto D, \text{ and } S \propto D + 2\delta.$$

Equation [4] would then become

$$C'\,(T - T_1)\,(D + 2\delta) = (T_1^4 - T_2^4)\,D \ldots\ldots\ldots [9]$$

where C' embodied all the constants.

It should be remembered that the constant C' embodied the convection constant, which was affected by the velocity and the density of gases, and radiation constant, which was affected by the condition of exposure of the couple. So when any one of these factors changed the constant must be changed also. It was also probable that the thickness of the gas film changed with the velocity of gases passing the couple. However, the data availing did not justify more detailed analysis of the equation. On account of the fourth-power variable, the equation was rather cumbersome to work with. The work could be made somewhat easier by making T_2 equal to one and expressing the other temperatures as ratios of T_2, remembering what this provisional unit was and changing the final results into the standard units. Such substitution of units eliminated one fourth-power factor.

Using this method of arbitrary temperature units, and $2\delta = 0.08$ in. and $C' = 3.9$, the equation fitted the curves A and B of Fig. 6 of the paper. The readings for both of these curves were taken under the same conditions of exposure and about the same velocity of gases.

For curve R the conditions of exposure and the velocity of gases were entirely different, so the constant C' must be changed. If the constant was made equal to 12, the equation would fit the curve R. The value of $C' = 10.8$ satisfied the curve M.

SCIENTIFIC METHODS OF MANAGEMENT PRESENTED BY MR. THOMPSON

A comprehensive paper entitled Development of Scientific Methods of Management in a Manufacturing Plant, by Sanford E. Thompson and his associates, was then presented by Mr. Thompson. During the presentation of this paper and discussion, President Hollis relinquished the chair to Mr. Max Toltz, Manager of the Society. A summary of the paper follows:

The authors present in considerable detail the outline of the development of scientific methods as applied to the ordinary manufacturing plant. To make this a more concrete illustration, the discussion is centered in the plants known as the Eastern Manufacturing Company, at Bangor and Lincoln, Maine, one of the largest concerns in the country manufacturing writing paper as its final product. The development of scientific methods at these mills, however, is not, as one might assume, descriptive of a simple and comparatively localized industry. As a matter of fact, the processes involved in pulp and paper making are similar in type, so far as management methods—not in specific technique—are concerned, to a vast number of industries.

The paper was discussed orally by Frank B. Gilbreth, who illustrated his remarks with lantern slides, W. H. Carrier, Max Toltz, Calvin W. Rice and Harrington Emerson.

Frank B. Gilbreth said that he wanted to call attention to the relation of the address on the previous evening by President Hollis to the subject of Mr. Thompson's most admirable paper. He was tremendously impressed by Mr. Thompson's talk, because he had been in Europe several times since the war began, and it was no exaggeration to say that millions of our boys would be on the battlefields after the war was over. We could not help that, but we could help the waste that was going on in this country at the present time, and the waste that would continue to go on after the war. From this standpoint he wished to take great exceptions to Mr. Thompson's admirable paper in that he followed out the procedure of his predecessors in giving the impression that there were such things as elementary units in stop watch time study, and that the data obtained from such study were accurate, transferable and of permanent value.

He wanted to call attention to the fact that the Society could not go very far in utilizing data unless they were in such form that they were usable by all the members. Stop watch time study is inaccurate, through the fact that the variable of the human element is involved in pressing the stop watch. It is not transferable, in that it does not provide for recording the surrounding conditions under which the observed activity takes place. For these two reasons, among others, it lacks permanent value.

It is possible to obtain accurate records of activity that include not only the time taken by the activity, but by the elementary units of which it is composed, through methods that are inexpensive, available and adequate. Through the use of the micromotion method and the cyclegraph method, which he illustrated by lantern slides, it is possible to obtain data that are so complete and so accurate that they are usable at any time by any person. From these data may be obtained charts that enable one to transfer the facts obtained not only from one activity to another, but from one type of worker to another who has an entirely different mental, physical, or material equipment.[1]

The special importance of these facts at this time is their relation to waste elimination. If we are to do our part in the savings that are today so necessary, we must begin to collect our data in a more economical fashion, and to put them into such shape that they may be universally useful in the shortest amount of time possible. We would, therefore, urge such men as Mr. Thompson, who has both the natural ability and the training that lead to expertness in observing and recording data, to discard inaccurate devices and to insure that the results of their valuable investigations are both immediately and permanently usable.

W. H. Carrier said that it seemed rather remarkable that time study as related to efficiency as a whole from a scientific and from a manufacturing standpoint had progressed so little in the paper-making art in the last number of years as compared with other arts in this country, particularly with reference to the work in the machine room. He was not a paper-mill man, but had been connected with problems in paper mills where the lack of manufacturing efficiency in the art of paper production had been most striking.

It had been determined by several different observers for instance, that in the process of the machine room in the drawing of the paper from 30 to 50 per cent of the possible strength of the paper was lost; and that the cost of producing paper of a standard as high as writing paper was nearly double what it might be if improved methods were introduced and studies made.

Even at the present date it had been shown by actual tests to be possible either to increase the strength of the paper or decrease the cost of a given standard from 5 to 15 per cent by

[1] See Motion Study for the Crippled Soldier, Jour. Am. Soc. M. E., December, 1915.

the use of improved methods, and at the same time to increase the output 10 to 20 per cent by the use of improvements in drying, particularly the application of air and the proper handling of the rolls.

Comparatively few machine rooms were being provided with improved machinery, although their number was increasing. But there should be a thorough study made of the possibilities which would result, he was certain, in a practical revolution of the process of paper making by machinery.

Calvin W. Rice asked what proportion of the value of the product of a paper mill the cost of counting of the sheets represented. He asked whether the product had now been developed to such a uniformity that the number of sheets could be arrived at by weighing them, and if not, whether other processes had been found which would avoid the expense of counting.

Harrington Emerson said that some seven years ago he was engaged to standardize the work in a paper mill very similar in size to one described in the paper. He went through all the departments and standardized the work. There were at least 3500 different varieties of paper, and he was not certain but what there were 35,000. A great deal of work done there would have been very useful to Mr. Thompson at the beginning of his studies, and with it he would undoubtedly have extended the studies already made.

This is mentioned because Mr. Emerson feels that he also is duplicating work already more thoroughly done by Mr. Thompson and others, and he regrets that there is no available clearing house of experiences.

As an evidence of the thoroughness with which some of the work was done, he would say that the plant in question was the only place in the world that he knew of in which labor costs were immediately and accurately so distributed that in nine months they were not one mill out in the distribution of the work of 600 or 700 men, and the record was complete at 10 a. m. of the day following. The work was performed by three girls, one of whom was a substitute.

CLOSURE BY MR. THOMPSON

Sanford E. Thompson replied to Mr. Rice that sheets still had to be counted. We had not reached the point where we could accurately determine the count by the weight. The cost of counting, however, using the rubber finger tip, is small and is useful in separating small lots.

He considered that Mr. Carrier was too low in his percentages of possible cost reduction. There was a chance for an appreciable increase in production and improvement in quality by radical changes in machinery, not only in the paper machine but also in the beating engines, and these problems were now being studied in the mills referred to in the paper. They were still using in all paper mills the Hollander beating engine that was invented not less than fifty years ago.

Mr. Gilbreth was correct in his statement that time study was capable of further standardization, and we had gone only a very short way in the developing of standard methods of taking time and in getting these methods so that the results of different operators would be comparable. He was not yet quite ready to say, however, that Mr. Gilbreth had the plan that would entirely revolutionize the taking of times. At the same time, the general principle of getting with his pictures, as he did, the methods of doing the work was of considerable value in many cases; and there was no question, even in his mind, that often that might be vital interest, and should be applied.

MR. WEAVER'S PAPER PRESENTED BY TITLE

The fifth and last paper of the session, on Disk-Wheel Stress Determination, by S. H. Weaver, was presented by title only, and will be published in full in the Transactions of the Society.

JOINT SESSION WITH MACHINE TOOL BUILDERS, TUESDAY AFTERNOON

A JOINT Session of The American Society of Mechanical Engineers and the National Machine Tool Builders' Association was called to order by President Hollis of the former Society. An audience numbering 400 of the members of the two organizations was present.

The Chairman, in opening the session, expressed the high satisfaction on the part of the two societies with this joint meeting, which he hoped was only the beginning of many such meetings, since the two associations belonged very much together and could work together very effectively.

The Chairman introduced Mr. James Hartness, who presented resolutions of appreciation and condolence on the death of Mr. William Lodge, President of the Lodge and Shipley Machine Tool Company, of Cincinnati, a member of The American Society of Mechanical Engineers for 27 years, and one of the organizers of the National Machine Tool Builders' Association and its president for two years.

Dean Herman Schneider, College of Engineering, University of Cincinnati, was then introduced and delivered an interesting and forceful illustrated address upon the subject of The Trend in Engineering Training. Dean Schneider's address will be given in full in a subsequent issue; the purport of this paper is conveyed by the following paragraphs:

THE TREND IN ENGINEERING TRAINING

"It is interesting to note that prior to fifteen years ago convention programs dealt almost exclusively with materials and the natural laws governing them. About fifteen years ago, however, there began to appear some papers on organization, which was then becoming a pressing problem. More recently we have been accustomed in conventions to a new phrase, 'the human element in industry.' These three are the great divisions of production: materials, organization, and men.

"Courses of study in engineering colleges have followed the needs expressed in conventions, so that necessarily, in the early days, the courses of study for engineers dealt almost exclusively with materials and their laws, and the engineering colleges straightway attempted the solution of the problem of materials. There grew up college laboratories wherein materials could be analyzed and the laws governing them ascertained.

"A little later, when engineers began to take up the problem of production so far as organization was concerned, the colleges introduced courses in organization. None of those courses is as yet satisfactory, however, for there are no laboratories available in the universities for the study of organization, which must, therefore, be made from books.

"More recently, when engineers thought the pressing problem was what was called 'the human element in production,' the colleges became confronted with the problem of ascertaining some sort of relation which would give a fairly equal and just measure of interest and study in the three elements of materials, organization, and men.

"The trend of engineering training indicates that there will be three types of attempts made to solve these problems so far as engineering schools are concerned. First, there will be the attempt that has been made in some colleges—not to conduct a great laboratory, but to confine a large part of the study to books. We have that kind of college in evidence in the study, for example, of organization exclusively from books. That type of American college will attempt also the study of the man problem out of books; in other words the sequestered method, the withdrawing of men from contact with industry in order to study industry, will prevail in some colleges. There will be the same trend in the study of organization and men that has prevailed in the study of materials.

"In the second place, there is a movement, inaugurated by the Massachusetts Institute of Technology, whereby arrangements are made with manufacturing concerns to have in those concerns laboratories and classrooms for the students of the Institute. In the later years of the course, according to that program, these young men are taken from the university and go, so to speak, to a secondary school—an accessory school—at some manufacturing plant where they observe the work done and after classes are instructed in the manner of doing the work.

"The Massachusetts Institute of Technology has made arrangements with a number of organizations, such as cement companies, chemical companies, and so on, for those students at the present time who are studying chemical engineering, whereby classrooms are put in the building in or near the plant, and the students go to the classes, and then go out into the shops to observe the work done in the actual commercial department of that particular concern. They spend a year in this. You can see that that scheme is possible of enlargement, and it offers a splendid opportunity for the study, at fairly close hand, of the three elements of production—materials, organization and men.

"The third attempt is one which has been inaugurated at the University of Cincinnati, and is known as 'the coöperative' system. In this system a plunge is made straight into the industry. The young men are sent out right at once upon entering their course into the work of the industries. They are not sent into classrooms there, but are sent out to do actual work and become part of the organization. They start at the very bottom. The civil engineer starts with a pick and shovel; the mechanical engineer starts in the factory or machine shop as a helper; the electrical engineer starts in the machine shop on electrical work, and so on."

Dean Schneider then exhibited a number of lantern slides exemplifying the main difference between the three types. He concluded:

"The first type is easy to operate because the whole field of operation is within the scope of the men who operate it.

"The second type is a little more difficult, because the school has to deal with different concerns, and arrangements have to be made so that there is no confusion in the work.

"The third type, the coöperative system, is extremely difficult of operation, for the problems are those that arise in the shops in addition to those in the University.

"The men operating the coöperative system are confronted daily with the same problems that the manufacturers have to meet, because their young men are working in the manufacturing concerns and become part of the problem.

"The University has had to cope with very peculiar conditions, looking at the problem from the industrial and educational point of view of the man who works and the man who employs; because the young men are working, they are working men governed by rules. At the same time the University is concerned with the major problem, the big problem of engineering and of efficient and economic production, so that the University authorities governing that course have to meet these vexing problems right along.

"The difficulty of operation is about the only thing in the way of the adoption of the coöperative plan, outside of any question that may arise as to the fundamental philosophy of the work itself. The differences that arise as to the value of this kind of work are very proper."

W. F. M. Goss said that all who had been concerned with the problems of technical education had looked with great interest upon the coöperative undertakings of Cincinnati University. These undertakings represented a procedure which was practicable only in a few communities, so that in considering their merits one was forced early to recognize this limitation. This statement emphasized the fact that the University of Cincinnati was to be congratulated not only upon the possession of Dr. Schneider, but also upon the wonderful environment which the peculiar activities of the city of Cincinnati supplied. The coöperative plan in techincal education as developed by Dr. Schneider was, he took it, a logical adaptation of means to an end. Through its adoption a great work in education had been and was being accomplished. It was to this fact that he especially wished to bear testimony. He wanted also to express to Dr. Schneider the pleasure and satisfaction he had had in listening to his masterful presentation.

Frederick W. Putnam said he had come to Cincinnati to study the coöperative system in the high schools, and found that he had also a chance to study the same system in the University. It seemed to him that the people in that city owed a tremendous debt not only to Dean Schneider, but to the Superintendent of Public Schools.

He believed that in his own city, Providence, their problem was working out and they were going to have the hearty coöperation of the manufacturers, including Mr. Luther D. Burlingame, of the Brown & Sharpe Mfg. Co., Mr. Arthur H. Annan, of the Rhode Island Tool Co., and Mr. D. M. Bartlett, of the Builders' Iron Foundry, all of whom had spent money on their undertaking. He thought that all of the success they had made was due largely to the fact that the manufacturers were interested, and that they wanted the boys to have a chance. They were trying to see that they got a fair, square deal all the way through. He believed that when those boys were through they would have gotten a good start for the active business of life because of the honest and sincere coöperation on the part of the manufacturers of the city of Providence.

James Hartness asked for information as to how many places the coöperative course under discussion had been applied in the United States. He understood it had been put into three or four hundred high schools, and he asked whether it was not an unqualified success. He knew that in Springfield, Vt., they considered it so.

If the movement were to go forward, as he thought it should, in all or in many centers, he thought we should all know about it, so that we could carry it home, where we could

bring our interest to bear to see that such things were given to the youth of our own places.

R. Poliakoff[1] described how the practical education of the students was carried on in the Technical Institute in Moscow, Russia, which had been reorganized and put on a new basis in 1870 so as to correspond with the system at that time prevailing in the engineering schools of Germany.

At the Centennial Exposition, in 1876, the school had exhibited quite a number of specimens of the work of its students, who at that time were required to spend three or four days weekly, from six to eight hours every day, in the shops attached to the school.

Very complimentary reports had been made about the students' exhibit at the Exposition, one of them appearing in the bulletins of the United States Bureau of Education. The exhibit itself would, he believed, still be found in the machine shops of the Massachusetts Institute of Technology.

As time went on the national trend had changed, and they had begun to believe that the student must know something else in addition to shopwork—he must know more about theory. For that reason they had gradually steered away from too much work in the shops.

Some twenty years ago, when he was a student himself, three days a week in the shops on filing, chipping, turning, etc., was required, also work in shops where small steam engines, compressors, lathes, shapers, etc., were made. The students had to work in those shops just the same as the ordinary workmen, and make out reports as to the progress of their work. Since about 1905, however, those in charge of the Russian schools had begun to think that different methods should be employed, and laboratories had been organized. To give an idea as to the size of some of these, he mentioned that the textile laboratory comprised a regular textile mill, a building three stories high, and the machinery installed in it probably represented an investment of $150,000. The students were afforded there an opportunity to pass from one machine to another. The school employed a number of practical men from a factory who worked with the students, and in that way he believed they turned out very good textile engineers who could go right into a factory and start to work there. In addition to that, every student that worked in that textile industry was expected to spend two or three summers in some mill in order that he might become a good practical engineer, and so that as soon as he was graduated he would be sure of finding a position.

In regard to machine-shop practice, the system at the Institute was a little different. They had still some shops which had not been abandoned, for instance, the practical machine shops in which various kinds of machinery were turned out. They had found out, however, that it did not pay a school to run such a shop on a commercial basis, and on the other hand they believed that only when it was run on a commercial basis could it be used as an educational institution for practical work; therefore, they simply rented the shop to a private concern, which concern ran the shop, and the students had the right of access to all the other shops of this concern, and worked in the shops under the guidance of the Institute's own engineers. The steam-engine laboratory supplied steam also to this private establishment, and, of course, it had to supply it at the proper time and in the proper quantities. The work was arranged in such a way that there was complete coördination of all the different sections.

[1] Assistant Professor of Mechanical Technology, Technical Institute, Moscow, Russia.

The students worked also for two summers, sometimes for six months every year, in the shops of private concerns outside the school. They were paid on an hourly-rate basis, and as many of them had not sufficient means to enable them to support themselves, they depended to a great extent upon these earnings, and so they attended to their work very regularly.

During the last three or four years some changes had been made in the courses, and less work was done in the school in the way of machine-shop practice and more in the private works. So, while this was of course not a coöperative system in the way that Dean Schneider operated it, he believed, there was not so much difference between the two systems. It was, after all, only a question of coördination; and they were trying to carry on their system in the best manner. Local conditions of course had to govern, and there were always variations that were suitable to special needs or localities. What might suit one might not suit another; but he thought the prevailing idea in all cases was to give the students some practical education outside of the school, leaving to the school the more theoretical part of their education.

Calvin W. Rice said he was hopeful that the Society and the National Machine Tool Builders' Association would some day follow the lead of the other professional societies of the world in having a committee on engineering education. The professional societies of other countries had felt it an obligation to establish a relation between the teaching of engineering and the work of the societies. He did not know of any such definite relation in America between the professional societies and the colleges, and he thought that there should be a definite relation. He was hopeful that as an aftermath of this address some members of our Society would volunteer to make a sacrifice of time and study, and develop a committee to so correlate the teaching of engineering that the students when they were graduated would be acceptable to the profession and to the industries.

E. F. Du Brul, who has taken an active part in interesting manufacturers of Cincinnati in Dean Schneider's coöperative plan, said the main difficulty encountered in conducting the coöperative course lay in procuring practical teachers of commercial experience who were willing and competent to teach engineering students at work in the industries every alternate two weeks. Not every technical college professor was willing to teach at the college eleven months a year, instead of the usual nine months. In fact, some of the men must even be content with only two weeks' vacation.

Mr. Du Brul said that it took a number of years to overcome academic inertia in Cincinnati, where conditions made that inertia less than it probably would be anywhere else. But now the manufacturers of Cincinnati who employed, paid and trained these students were getting results from them eminently more satisfactory than they ever got, or could get from the ordinary type of engineering student who comes in a factory after graduation.

There were now 500 students enrolled in the engineering college, and the only industrial difficulty was that the college had no room for more. From 3000 to 4000 applications were received every year, from which only about 200 could be accepted.

Mr. Du Brul stated that a manager of a large concern recently wrote Dean Schneider, stating that he had read a magazine article about the coöperative course and would like to try six graduates. He said that his company would pay them $60.00 per month the first year, $75.00 the second year

and $100.00 the third year, and whatever they were worth thereafter. It was fair to assume that later salaries would be $110.00 to $125.00 per month during the fourth year.

Dean Schneider replied that he could not supply any of his graduates under those conditions, because firms that were employing the students were paying them for the time they worked on an average basis of $90.00 to $100.00 per month during their last terms in college, and that such firms found these men so valuable that their salaries at the end of the third year after graduation averaged about $3000.00 per year. "Is the average graduate of the average technical college," he asked, "worth $3000.00 a year at the end of his third year after graduation?"

Some educators to whom this question had been put very bitterly charged that this was putting education on a sordid commercial basis, saying that a money standard should not be applied to measure the value of an engineering education. To this the speaker said he had replied that a laborer was worthy of his hire, and that since most engineers ultimately earn their living in commercial establishments, the salary an engineer could draw was a fair measure of his worth to his employer. If therefore, the average graduate of the coöperative course appeared to be worth more to the users of trained men than was the average graduate of the traditional course, the commercial standard proved the coöperative course to be the better course, both commercially and educationally.

It had been stated that at Providence, the manufacturers did not want to make money out of the coöperative-high-school students. In Cincinnati it was understood that, far from having any tinge of charity or tolerance, the coöperative course in the University did return a direct and immediate profit to all concerned. The Cincinnati manufacturers were not unfairly exploiting the students, but were making money by employing them, just as they did by employing any other employees.

Mr. Du Brul concluded with the statement that the plan was truly coöperative. The employers made a direct profit on the regular output of the students and they made a larger though intangible profit by training those students to be the sort of engineers that they required in the industries. The students profited directly because a great majority of them could not procure an engineering education, due to the lack of funds, without some plan that helped them to pay a large part of their expenses. They had a further profit in the opportunity to secure an engineering education of a kind that fitted them to hold a better job than they could otherwise get after graduation. The University profited directly in that, being very limited in its funds, the Schneider plan enabled it to educate more and better engineers for the amount available, at a lower cost per head than any other institution could show under the traditional plan. The University's indirect gain was the great reputation that this plan had made for the College and its educational product in a very short time.

Dean Schneider, in his closure, answered all the points brought up by the several discussers, enumerating the institutions which were using the coöperative plan and reciting their experiences. His closure will be published with his full address.

Dr. Otto P. Geier then delivered an address on The Human Potential in Industry, which is published in full below.

THE HUMAN POTENTIAL IN INDUSTRY

By DR. OTTO P. GEIER,[1] CINCINNATI, O.

For the past three years history has been writing the terrible story of the human potential in modern war. As a result of a long period of peace, we Americans had looked upon war as a most remote possibility, attested to most strikingly by our present state of utter unpreparedness. As we reflect, it appears now we were not measuring nations by their fighting strength, but rather by their social, industrial and commercial strength. Nations were tabulated for their rate of production and consumption. This differential had its social as well as its economic effect. It produced state and private wealth. It produced leisure, the arts, extended educational and health measures, and raised the standard of living. In brief, the world was in keen competition not only in business life, but in social life. Nations were striving to outdo each other in promoting financial success, health and happiness for their people. Individualism had reached its zenith and the philosophy of collectivism was just appearing above the horizon.

It was rather our subconscious minds that recognized the great sea power of England and the militaristic spirit of Germany. Our real attention was focused, not on the plans and intrigues of governments, but rather on the national characteristics of their peoples. We thought of London as the financial center of the world, of the Englishman as the world traveler, a lover of outdoor life and sports, an educated gentleman and judge of the fine arts.

When we traveled in Germany we admired her order and cleanliness, her *Gemüthlichkeit.* The world paid homage to her philosophers, revered her musicians, studied and copied her educational systems and longed for her thoroughness and scientific capacity.

POTENTIAL OF WAR

But the bloody struggle of the past two years has changed our viewpoint of these nations. War, with all its horrors, its terrors, has changed these peoples. The human potential of nations is no longer directed at the creation of comforts, contentment and health, but the backs are bending low under the struggle of destruction of property and life. National efficiency is now expressed in new terms.

Shortly after the program for the Spring Meeting of this Society began to take form, our country entered the war. There were those who doubted the advisability of holding the meeting. Our fearful unpreparedness produced a public state of mind akin to hysteria. We have scarcely had our sober, serious second thought. Democracy is being subjected to the acid test. There are few so daring as to prophesy what failures and what successes we shall find. Of one thing we see signs. Our nation is finding itself. We are trying to forget and forgive ourselves for our "spread eagle" and forget our jingoism. Even in the early stages of preparedness we are intensively appreciating, as never before, the stuff that other nations are made of. Their capacity to produce, their silent ability to suffer, sets us to wonder.

[1] Cincinnati Milling Machine Company.

AMERICA REBORN

Perhaps, for the first time since the Civil War, we are thinking together. Our national consciousness has been reborn. The pettiness in us is disappearing and true Americanism is coming to the foreground. Our faces are turned to the common enemy. We have turned our backs on the paltry bickerings of the past. We are witnessing the first truce in the century-old strife between labor and capital.

This is a day that calls for statesmen as well as soldiers, for calmness as well as courage, for patience and patriotism, for virtue and vigor, for faith and faithfulness, for health as well as willingness to die. This day calls for social reconstruction as well as enemy destruction. Huge is the task in which *all* should find a place to do with all their hearts.

POTENTIAL OF INDUSTRY THE POTENTIAL OF THE NATIONS

And what tasks has our entering the war brought to industry? Huge production? Yes! But is that all? Have not old truths as to the value of the conservation of labor taken new form, new emphasis? Has not The Human Potential in Industry in the nations abroad finally been the measure of their potential on the battlefield? Has the interdependence of man ever been more fully demonstrated? Has the mutual dependence of labor and capital ever been so strikingly proved? Have we ever witnessed such limitless industrial energy and output? Has it occurred to all of us Americans, that Europe's industrial experience of the past three years holds not only a lesson but a warning? Militant and efficiently industrial England of war times will be succeeded by industrially militant England of peace times. Labor and capital in England, Germany and in France, having learned the mutual advantage of coöperation in war, are not likely to give up this advantage and return to the destructive internal warfare of former days.

OUR NEW COMPETITION

The question that presents itself is this: Can we keep pace with them in war, and will we keep pace industrially after the war? Can we stand this new type of competition unless we likewise enter upon the program of the new social order? Will not the programs of our National Association of Employers, chiefly defensive in the past, necessarily become socially constructive? Will not labor now have to seek leadership capable of best adjusting itself to these forward-looking steps.

FORWARD-LOOKING INDUSTRY

War has lifted the discussion of "the human potential in industry" out of the realms of philosophy and has used it as the foundation stone of a national economic policy. The Council of National Defense has appointed a committee on the conservation of the health and welfare of the worker, and in the interest of the health and productiveness of labor proposes to establish definite standards of plant operation. The human potential of the nation is needed at its maximum, for the country cannot afford the usual labor losses due to accident, disease or fatigue, and industrial poisoning.

A right-minded, forward-looking man does not wait for compulsory legislation to develop his business organization to the highest degree of efficiency. This type of man, for years, has developed not only the administrative and technical divisions of his plant, but, when most successful, has given a great deal of thought to the human equation; the giving of happiness and meting out of justice to his employees. It has been a great satisfaction to him to find an economic method of lessening the human waste due to preventable accidents and occupational diseases. He noted that a healthy, contented employee was a more productive employee, who, in turn, was a higher type of citizen, demanding a better standard of living for himself and family, better protection for his children against disease, delinquency, and crime, and higher forms of community recreation. He recognized that right in his plant he could make his best contribution to the health and well-being of the worker, and that he had found, perhaps, the most tangible basis for coöperation between himself and his employees. To him it was apparent that by intensively studying the health of his workers he was establishing some splendid new points of contact between himself and his men.

MASTER AND MAN, THEN AND NOW

Industry must find a substitute for the valuable relationship of master and man which passed with the coming of greater industrial concentration. Then the master was teacher as well as craftsman and to a large degree a substitute for our modern continuation school, manual training and coöperative university engineering course. Master and man worked elbow to elbow. The master largely molded the thought and living of the man. Then they had real personality for each other. Now, in too many instances, the pay envelope expresses the only bond between the two. The man was graduated from his apprenticeship, frequently to set up a business of his own; now, industrial concentration practically hinders the establishment of the new small unit. Then, labor took part in the making of the mechanism and conceived the full purpose of the machine which he assisted the master in building; now, his work is more repetitive and limited to single parts of a machine, whose mechanism he may not understand.

TENEMENT STRIKES, LOCKOUTS

It was but natural that in this evolutionary process of industry, capital and labor should become more estranged. They not only worked farther apart, but lived farther apart, for with industrial concentration, community life changed, and the tenement district developed. The difference in their scale of living was more evident. Industrial discontent was more readily bred. Labor and capital organized themselves to meet strife, and strikes and lockouts were the natural outgrowth.

Neither master nor man can be held accountable for these unfortunate conditions, which were but the natural consequence of industrial evolution and the consequent crowding of population in cities. So engrossed were both labor and capital in adjusting themselves to the new conditions that the estrangement of these former partners in work came on quite unnoticed.

DISTRUST OF EARLY WELFARE WORK

Some years ago industry began to recognize its social obligation. It saw the economic advantage of substituting fine, light, well-ventilated buildings for the dark, unsanitary workshops of the good old days. It was at about the same period that many abortive attempts at so-called welfare work were started, which in most instances failed to make any real contribution to the better understanding of labor and capital. This sort of welfare work was established on purely paternal-

istic lines, was imposed upon the group of workers without their desire or consent, and all too frequently furnished that for which they had no real need. This type of welfare contributed to the social and superficial requirements of the man, and overlooked the fundamentals. It did not take into account the basic principle that the workman is very human, and that to get the best results out of any socializing effort you must first engage his coöperation. You must put him to work, so that he too may use his creative instincts, and enjoy with the employer the fruits of intelligent coöperative work. Welfare work of the former kind deserved failure and did fail. It was "built upon the sands" and was all too frequently washed away by the least wave of discontent among the workers. After the first strike, the returning man found the doors of the dining rooms, libraries, and club rooms closed upon him. The whole structure was weak and crumbled at the mere sign of a storm. Is it any wonder then that welfare work came into such disrepute with the worker and was so continuously and effectively used by the labor agitator?

BUILDERS OF MEN

It would indeed be a foolhardy individual who should attempt to interest the members of these organizations in that kind of welfare work. I am equally sure that most of the plants represented by this conference are already engaged in some effort to solve the great problem of human potential in industry. We are all groping our way toward finding the right method. If we can evolve a sound economic scheme for the establishment of a human-service department in industry, which day by day will pay dividends, which will reduce lost time for illness and accidents, reduce labor turnover, and quicken loyalty, we will not build up a "blockhouse" which will fall to pieces at the first sign of industrial strife. It will each day have served its purpose, secured a result worth while for itself, and will automatically, along with all other departments, be again set in motion the moment that the wheels of industry begin to turn.

I have faith in big industry. I believe that when builders of big enterprises sense their social opportunities they will also prove themselves to be builders of men. In time their widened perspective will include an active interest in national and local health problems, they will, for the sake of the men, use their good offices for better housing and transportation facilities. They will apply themselves to the great human problem of taking much of the drudgery out of work. With this new purpose in life will come a recompense which cannot be valued in mere dollars.

They will be instituting the first intelligent effort toward the alleviation of poverty and the establishment of social justice. Philanthropy and legislative effort to correct conditions have failed lamentably.

BUILD UPON HEALTH

The activities of the human-service department should be founded on intensive health work. Health is our most vital possession. The mere act of conserving the health is ennobling. Healthy bodies promote right thinking, right living, good habits, and it is upon such factors that intelligence, stability and loyalty are engendered. Unless we have these things, our employment departments, struggling with the labor turnover, our mutual-benefit societies and loan associations, our restaurants, our coöperative buying, our sanitary measures, will meet with but half of the deserved success.

ALL-DAY DISPENSARY

The point of approach to the human potential had best, therefore, be through the industrial dispensary. Under a high-grade physician it will be the great melting pot of the human experiences of men. Here the virtues and the weaknesses of the men will be most apparent. The physician will also be confessor, adviser, priest. Through him the employee may learn that it pays to be healthy, steady, and of good habits. He does not hesitate to preach the "Sober First" campaign.

An industrial dispensary, with a dental clinic as its adjunct, will advertise itself. It will come in daily contact with five per cent of the force, the equivalent of the whole force each month. To respond to all the possible services that grow out of these frequent contacts, it will require one full-time physician to every 750 employees.

The men will first use this department for their slight cuts and accidents; next they will begin to call the doctor's attention to some surgical defect with which they have been suffering.

DOUBLING WAGES

I recall the case of an Italian watchmaker with five children, whose complexion was pale and pasty. He seemed anxious to please his foreman, but his work, like his skin, remained rather pale. He had a bad record for absence and lateness. His average earnings amounted to $13.00 per week. Investigation showed that he had been suffering with hemorrhoids for twenty years and had been repeatedly advised against an operation. He had enough confidence in the plant physician to undergo the operation. As a result, his physical efficiency was raised, so that now his premium earnings are nearly as great as his weekly wages formerly were. In other words, the operation had practically doubled his wages. An inefficient man, an active candidate for the human scrap heap, one whose family had been on the poverty line for years, has been converted into a happy, productive citizen.

In an industrial all-day dispensary men will frequently learn that while they have been treated for rheumatism on the outside, they are actually suffering from broken arches. Again and again men will be found who are continually taking headache dope for headaches due either to gastric conditions or eye strain. Untold numbers of men will be found whose working capacity has been below normal; whom employers have always felt more or less sorry for and therefore did not discharge because they seemed anxious to make good, but they never quite "reached." Quite a lot of these will be found suffering with chronic intestinal toxaemia, while fully as many will be discovered whose lowered vitality has been induced by years of bad mouth hygiene, abscessed roots and pyorrhea. I am thinking just now of such a man who had been treated for rheumatism for years and who never was able to get out of the subnormal class of workers. A careful checking up showed pyorrhea of the teeth to be responsible. With six months' supervision and care, that man increased his earning capacity by nearly 100 per cent.

While speaking of mouth conditions, let me recall the case of a man who for three weeks suffered excruciating neuralgia of the face and head. He was the type of man that puts off going to a physician until the last moment. Examination showed that he had a very dirty mouth, a number of snags and some pyorrhea. X-ray showed an unerupted cuspid tooth lying horizontally, the pressure therefrom causing the pain. Twenty-four hours after the removal of this tooth, and the old snags, all pain disappeared. If the plant dentist

had been an average dentist no X-ray would have been called for and the man would, for weeks, have lost sleep and time from work, and have considerably reduced his vitality and working capacity.

In passing, we might mention one other case where the man was losing a day or two each week as a result of nausea, sleepy, draggy feeling, practically no ambition for work, and gradual loss of weight. Physical examination showed nothing unusual, except that the teeth were bad. Cleaning up the mouth and pulling out the old snags was followed by immediate improvement. The stomach trouble disappeared. In six weeks he gained seven pounds and had a new bite for work.

DIAGNOSIS NECESSARY

The plant dispensary, with the economic pressure back of it to get results, will go farther to establish a diagnosis than the family physician. It sees the financial advantage to the patient and to the company, to spend a few dollars for consultation or for X-ray. If the employee cannot pay for the consultation, the plant physician can always place his hands upon some consultant on the outside who will do the work for nothing. There is a drive behind the plant physician to get a quick result.

Too much cannot be said for physical examinations of employees. No one knows how many cases of incipient tuberculosis are present in his shop force. There are any number of men whose appetites are variable, who tire easily, but who have no cough or symptoms that would make them consult a physician; are perhaps merely irritable, and have a draggy feeling and no "pep." They attribute their weariness to the job. In so many cases of an early diagnosis of incipient tuberculosis, an enforced rest of a month or two will put these men on their feet again.

INDUSTRIAL CROSSED EYES

The development of the human potential with all of its mutual and economic advantages will not be introduced in industry where the employer does not possess some social vision. I am thinking just now of one narrow-visioned employer who was recently interviewed by someone who was anxious to gain a consensus of opinion as to the value of employees service departments. The total human equation in this particular industry, employing some 1100 men, was represented by a mutual aid to which the company contributed annually the large sum of \$100 (less than nine cents per man). It was necessary for that association at their annual picnics, given for the purpose of raising money, to invite employees of a number of other smaller concerns. In other words, for the sake of a few dollars raised by inviting outsiders, this company blindly encouraged the undermining of any good feelings of fellowship that might have been encouraged among its employees by this one annual getting-together. The same employer boasted that the efficiency plan of wages greatly reduced the cost of production, returning ten dollars for each dollar put into that system.

A LOW-BROW HIGH TURNOVER

In discussing his men he spoke only of their lack of loyalty and the lack of loyalty on the part of the foremen. With an injured air he told that petitions for the unionizing of the employees had been in circulation in his shop for two weeks with the full knowledge of the foremen before he discovered that fact. The result is, he says, that the shop is fully organized and the union has his company under its thumb. It seems that it had been the custom of this company to entertain the foremen once a month with a dinner and smoker, and that one of these entertainments was held the night before the discovery of the petitions. With stupid satisfaction he said that thereafter foremen's meetings ceased. It is not surprising to note in passing that the labor turnover in this plant is 305 per month. This man who gives the whole sum of \$100 toward the sole coöperative effort on the part of the men to care for themselves in times of illness loses \$100,000 per year in excessive labor turnover.

If I were called upon to make a diagnosis of that employer, I would venture to say that he had an aggravated case of mental strabismus or was mentally cross-eyed. He does not realize that the sound-minded industrial procession is passing him. He does not know that the movement for the conservation of the industrial worker marks the greatest change in the attitude of society of the twentieth century, that next to the municipality the industrial corporation is the largest social unit, that as such it partakes of many of the characteristics and functions of a governmental subdivision. He does not realize that his industry is an example of one selfishly administered, and as such is a menace to the peace, prosperity and happiness not only of the members of his industrial unit, but a menace to the rest of the community members. A coldly calculating, selfish enterprise, no matter how big, engenders selfishness, distrust, envy and hate in individuals in and about it. As a by-product it manufactures class feeling, which other social agencies vainly try to counteract. Conversely, a socially organized, profitable, and farsighted business enterprise, by its very existence, continuously creating more work for more people, is not only a great financial asset to the community, but is of definite social value as well. The first grows at the expense of society which gave it life. The second is one of the taproots of society. The first produces the malcontents, the industrial hobo, the I. W. W. The second creates intelligent, contented citizenship, the only hope of a democracy.

THE PHYSICIAN IN INDUSTRY

To men who are attempting to fit their enterprises to this latter classification, to men who are seriously at work solving the problem of the human potential in industry, permit me to say, that most of them are overlooking the possibilities for service that the socially minded physician may render employers and employees. The proper place has not yet been accorded him. He has not been given an opportunity to make one for himself. It doesn't count for much if surgeons are employed in a plant to care for the injured. The surgeon is in just the same relation to a business and the employees as is the electrical repair man who replaces the fuse and looks after short-circuits. What is needed is a doctor, a combination general repair and safety engineer, to look after the human machinery, to study stresses and strains on it, to give warning of a probable breakdown, to advise easing up on the load until the human mechanism has been readjusted, to do the hundred and one things that make for comfort of mind and body.

COST OF ILLNESS TO CAPITAL AND LABOR

When we are told by investigators that only one industrial worker in five in need of a physician calls one, we may know what this shortsightedness in them is costing in lost time. We may also know what great service the industrial dispensary may render.

The loss of wages to the worker on account of preventable illness runs annually to the billion dollar mark. To the employers the loss must surely be twice that amount when we remember what a large part bad health plays in inefficiency, in irregularity of attendance, with its consequent poverty and low standard of living, in its frequent shifting from job to job, in its undermining of character and stability, in inducing alcoholism and other vices. The man struggling against a physical defect uses up every ounce of energy and loyalty to support his family. Can he have any loyalty left? Is it human to expect it?

Are we going to meet this great medical and economic question by the general introduction of the physician in industry or are we going to sit idly by and permit the propagandists to persuade our legislators that compulsory sickness insurance alone will assure every worker adequate medical service. I personally disbelieve that compulsory sickness insurance will produce that result, but this legislation is inevitable, unless industry grasps its opportunity and shows society that it is willing to undertake a method of health insurance through its own dispensaries, whose costs will be negligible compared to compulsory sickness insurance and whose results for national health will be infinitely greater. If business isn't big enough to see the social and economic advantage of some system of self-imposed compulsory medical supervision of employees, then some of the most staunch opponents of compulsory sickness insurance will have to become its active proponents.

The industrial dispensary will lessen disease, increase the number of working days as well as working capacity and thereby increase the purchasing power for adequate medical service for the families of the workers. Medical care in industry is not a charity. It pays the best dividends of any department in business. It secures a new arm to the health department and makes possible preventive medicine on a scale yet undreamed of. Witness the reduction of 75 per cent of the lost time on account of illness in the employees of the Norton Company who use the medical department. In attacking directly such problems as personal hygiene, bad housing and living conditions, alcoholism and venereal disease, it will make a real contribution to national health and social welfare. It will immediately help cure the legislative mania with which the American people are cursed.

DISCUSSION

R. G. Williams emphasized Dr. Geier's statements, citing The Norton Grinding Company, which for a number of years had been practising a good many of the things Dr. Geier advocated. This company had an industrial health department, and it was just as indispensable as the telephone. They could prove to anyone interested that it was a dollars and cents proposition. As an example, soon after the department was installed and the men were just getting confidence in the work, an epidemic of grip broke out in the town. About half of the men who developed symptoms immediately got in touch with the plant physician; the other half did not, but held off as long as they could, and eventually lost considerable time. The men that used the hospital lost on an average 19.2 less hours per man per month than the men who did not.

Frank B. Gilbreth said that he wanted to emphasize one statement in this remarkable paper, not with the idea that it was the most important, but that that one thought would warrant the paper even without the rest of its contents. He referred to the conservation of industrial workers.

"We are very much interested in the work of conservation of industrial workers who have been crippled both in the war and in the industries," said Mr. Gilbreth. "It will probably surprise you to know that in Canada the number of cripples who return from the war is not as great as the number of industrial cripples for the same length of time in Canada. Statistics showing this may be obtained from those in charge of the re-education of the soldiers in Canada. Statistics from our own country are published in a remarkable book to be obtained from the Commissioner of Vital Statistics of the State of California.

"In the work that we have been doing with the coöperation of people in foreign countries, we have found a tremendous number of jobs for crippled soldiers as a result of which they can practically date the beginning of their financial prosperity from the time that they were injured. The work undertaken in finding occupation for these industrial cripples has been successful to an extent that has been perfectly astounding, and the same thing will apply to placement of re-educated industrial workers, if they are given proper attention.

"The great need is for adequate teaching, and this need can best be met now, when the subject of the cripple holds world-wide interest. Immediately after the war began I went to Washington to try to get a bureau started somewhere that would take up the question of providing teachers for crippled soldiers, with the idea of training them so that we could properly handle the cripples that will come back to us. It takes two years to teach anyone to handle the best methods of teaching cripples and it is absolutely necessary to make preparations *now*.

"Mistakes have been made in other countries in the matter of teaching crippled soldiers, where they have often been taught to make baskets, because the vocation of basket making might have been the only one that the teacher could teach.

"The cripple must be taught *not* primarily what the untrained teacher wants to teach, but *what he needs to learn*. He must be provided with an occupation that develops him mentally and physically, and that satisfies his desire to do "a man's job."

"It is the duty of this Society to see that the training for efficient teachers is provided not only in the schools and colleges, but also in the industries. The teachers must know how to prepare the cripples to go back into our shops and offices—must be able to furnish practical as well as theoretical knowledge.

"Then, when the need for re-educating war cripples is over, they can turn their energies to the cripples of the industries, to whom Dr. Geier has so eloquently called our attention."

F. A. Geier closed the session with a word of appreciation. He said it was the Local Committee that decided on what the program should be for the session, and he was very happy to feel from the applause that the subjects were well chosen. It was the Committee's purpose to impress upon the members of the two associations at this particular meeting the great value and their very great obligation in the matter of considering the worker in the shop.

They had had papers in both societies on the construction of buildings, on the construction of intricate mechanism, and on increased production. But the main thought among the Cincinnati Section was that they would like to impress those present that there was now the greatest opportunity put before them, namely, the earnest and sincere study and investigation of the human element.

FIRST MUNITIONS SESSION, ALL DAY WEDNESDAY

THE feature of the Spring Meeting which proved of great interest from the professional standpoint was the topical discussion arranged by the Committee on Meetings on the Fundamental Problems Involved in the Manufacture of Munitions. It was planned to have two sessions for this discussion, on Wednesday and Thursday mornings, May 23 and 24. The subject was considered so important, however, and the interest was so sustained that the Wednesday morning session was continued throughout the afternoon of that day, in spite of the fact that a boat ride on the Ohio River had been arranged by the local Committee for Wednesday afternoon.

The attendance at all of the sessions was large, numbering at times as many as 300. President Hollis, who presided at the beginning of each session, called to his assistance as chairmen L. P. Alford of the Committee on Meetings and John H. Barr, Manager, and William B. Jackson, Vice-President, Am.Soc.M.E. Representatives of the Government in attendance were Lieutenant-Commander R. R. Adams and Major P. S. Bond.

The initial discussions, or papers, published in THE JOURNAL for May, touched upon some of the vital problems which manufacturers of munitions have to meet, such as munitions contracts and their financing, organization and procuring of special machines, designing for quantity manufacture, procuring materials, limits and tolerances, gages and small tools and inspection.

There was a strong sentiment at the meeting in favor of some action by the Society of a constructive nature which would be helpful alike to the Government and to those who might be called upon to manufacture munitions.

A deep impression was made by representatives from Canadian manufacturing plants, who emphasized the importance of coöperation among manufacturers, and the pooling of information by manufacturers for the benefit of all concerned,—in other words, coöperative manufacturing as carried on in Canada, as opposed to competitive manufacturing which has prevailed to so large an extent in this country.

Naturally, there was much interest in the relations of the small manufacturer who might be a sub-contractor for the large manufacturer. There was considerable discussion also, as to the possibility of the Society becoming a clearing house for information, even to the extent of undertaking the collection and publication of data upon the manufacture of munitions in the form of a handbook or otherwise.

In order that the discussion might be without restriction and of the utmost benefit to those in attendance, it was agreed that where requested the remarks would not be reported. In several instances this desire was carried out.

At this session the following papers were presented, the first three in the morning, and the last three in the afternoon:

MUNITIONS CONTRACTS AND THEIR FINANCING, Frederick A. Waldron.

ORGANIZING FOR MUNITIONS MANUFACTURE, Arthur L. Humphrey.

ORGANIZATION FOR MUNITIONS MANUFACTURE, Harry L. Coe.

PROCURING SPECIAL MACHINES FOR MUNITIONS MANUFACTURE, H. V. Haight

PRACTICAL WARTIME SHELL MAKING, Lucien I. Yeomans

THE DESIGN OF MUNITIONS FOR QUANTITY MANUFACTURE, J. E. Otterson.

GENERAL DISCUSSION—REMARKS BY LIEUT-COMMANDER R. R. ADAMS, U. S. N.

Lieut.-Commander R. R. Adams,[1] U. S. N., who attended the meeting as the official representative of the Bureau of Ordnance, said the policy of the Bureau had been to direct its representatives "to coöperate with the various manufacturing firms to which they are accredited in every consistent and proper manner." It had also given directions that the inspector facilitate the manufacture and expedite deliveries wherever possible, provided that satisfactory and acceptable material was procured by the Government. To accomplish this in every instance was impossible, but by the exercise of tact and patience in the case of firms unacquainted with Government methods and requirements, it was believed that many of the difficulties which would ordinarily crop up could be eliminated.

The Bureau desired its representatives to advise the firms in their district as fully as possible, and where possible to make decisions within the scope of their professional knowledge as to the suitability of the materials to be used.

Even with these instructions, cases would arise which had to be referred to the Bureau of Ordnance, but by the use of telegrams and long-distance telephones for important decisions serious delays in manufacture could be eliminated. The Bureau had requested its representatives to make suggestions to the manufacturers, where it was thought that such suggestions would be of assistance, or to give any general information which would help in the manufacture of material required by the Government. Information was volunteered if it would aid manufacturing processes and at the same time did not violate confidential matters disclosed by other firms. But matters of a confidential nature which had been confided to the Inspector were not to be divulged under any conditions.

The Government representative or his inspector was directed to assist in the manufacture of material as far as practicable in addition to inspecting it for acceptance, where such assistance was requested. Our country desired to prevent trouble with regard to new munitions plants such as was experienced in Canada for some months after the outbreak of the war. Many munitions plants in Canada failed to turn out satisfactory products because of lack of coöperation among the plants. This had finally led all plants to pool their experience, and the success of one plant was followed by others until all had the necessary experience. This should be done in this country in the near future, and all information and experience required for the manufacture of munitions should be pooled by the different plants so as to assist other plants, especially the new ones.

Reuben Hill commented on present conditions as they existed in this country with respect to the war, and gave sound advice to those who earnestly desired to serve the Government. He spoke from his experience in munitions manufacture in Canada, and had the closest attention of the audience.

The speaker deplored the apparent apathy in relation to the organization of our industrial forces to support those men that we must necessarily and immediately send forward to the front. He also took the view that the general public were not taking the situation seriously enough, and that they would not realize the gravity of the situation until the men that we had sent to the front had been killed. This was based on the fact that the people in Canada were living very close to the war;

[1] Inspector of Ordnance, Munhall, Pa.

in other words, they had been "burying their dead." Therefore they realized how essential it was to back up the men at the front with sufficient material and munitions in order that a great deal more might be accomplished. He also referred to the sad conditions of the past, which was general history now, in relation to the bad start that Great Britain and France made by allowing the best men to push to the front at the beginning, and thereby crippling the maintenance of the industrial support.

He further emphasized the necessity of prompt and immediate attention to the organization of the industrial forces which was necessary now, suggesting that the Government take a more coöperative and guiding activity in relation to the manufacturer, thereby departing from the peace-time methods of arbitrarily giving a contract, and then at a certain time sending some one forward to inspect the work, and either arbitrarily accepting it or rejecting it.

He also advocated that the Society, by reason of its membership in practical engineering, should be of great assistance to the Government in formulating an ideal coöperative industrial scheme, similar to that prevailing in Canada, with the Imperial Munitions Board.

Frank B. Gilbreth emphasized the importance of recording all details, including the time element, with respect to industrial operations, and referred to the use of the micromotion film for this purpose. He said in part:

"We hear much of the loss of information to the world when the great library at Alexandria was destroyed, but we hear little or nothing about the wonderful amount of information in the heads of our workingmen, who have not been properly trained to pass on that information in literary form so that the public can get the benefit of it.

"The best method of doing any kind of work does not lie in the consecutive acts of any one worker, but is synthesized from records of methods of many expert workers. When these skilled but uneducated experts referred to die off without passing on their information in any way, the best elements of the methods that should be recorded and passed on are lost to us forever.

"There has been some confusion between the ordinary motion picture film and the film used in making micromotion study. The micromotion film is the result of placing a timepiece that records the *time* element, and a cross-sectioned screen that records the *space* element in the field of the method to be photographed. The pictures are taken at varying rates of speed, and are then projected at the speed at which they are taken, at slower speeds and at more rapid speeds, in order to get different views of the operation being studied. The pictures are studied one at a time, the film being run forward and backward, and a cycle of motion being reviewed as many times as is desired. The two aims are, first to get all possible detailed information on the film, and second to get this information off the film and into the simultaneous motion-cycle charts, or such other form as will aid in transferring the information most easily and most efficiently to the learner. The stop watch can make no such adequate records as this. I would urge that all observations should be made once for all by the most scientific methods possible."

Harry E. Harris told something of the industrial mobilization carried out in Fairfield County, Conn., the county in which Bridgeport is located and which has been called the "Essen of America." He said in part:

"On April 4 the manufacturers in the county held a meeting with the members of the chambers of commerce, boards of trade, philanthropic societies, granges, and the Farm Bureau and organized a patriotic association which expects to raise in the neighborhood of one hundred thousand dollars from the people of the county and to have a membership which will embrace every man, woman and child.

"The object of this association is coöperation and there are six chief departments: Manufacturing, Transportation, Industrial, Relief, Welfare and Agricultural. The Industrial Department, which we are interested in as engineers, has ten divisions of work, one of which is the establishment of an interchange of measurements. The different manufacturers who have facilities for measuring have offered them to the association and experts in measuring who reside in the county have offered their services. Committees have been appointed which are already working in conjunction with Dr. Louis Fischer of the Bureau of Standards. The Association has offered its assistance to the Bureau of Standards and to the different manufacturers with a view to securing accurate local standards and means of measurement. It will be the aim to work in conjunction with the different Government inspectors.

"There is a committee for securing the coöperation of labor, one on industrial efficiency, and one on the training of employees."

Lieutenant-Commander Adams in response to an inquiry as to what could be done to facilitate delivery of material, said that the steel-manufacturing firms in this country had authorized the Government to call on them for certain amounts of steel at a fixed price; but at the present moment most of those firms have been filled up with Government material. He said that there were a number of steel firms throughout the country that were not doing their part. That question was being considered in Washington, and would probably be taken up in the near future. If any firm in his district had difficulty in getting steel, he took it up direct with the steel corporation in the district and had so far succeeded in getting steel within 90 days, sometimes in two weeks. The question was being considered at Washington of giving more power to some Government official who would have power to assign certain deliveries of steel to certain plants at a fixed price.

President Hollis urged that some constructive action be taken by the meeting as the most obvious thing to do, inasmuch as the men in attendance represented the productive industries of the country. He suggested that a committee be appointed to draw up resolutions for consideration at the next session, offering helpful suggestions to the Government and possibly suggesting the establishment of an effective central bureau on the whole subject of gages. He believed it was most important that some such action be taken by the Society to help accomplish the thing that Canada and England have required a long time to bring about, so that there would be fewer mistakes to start with.

W. H. Carrier expressed his approval of the suggestion by President Hollis and said that he himself was about to suggest a coöperative board to determine what mechanical manufacturing problems could best be handled by the engineers and manufacturers of the Society. Such a board should take a census of the membership to determine what the individual members were capable of doing, to find out which of them were specialists in different lines that would be useful to the Government—in short, what the problems were and who were the men to solve them.

As a result of a motion by Harry L. Coe, it was voted to ask that a committee be appointed to draw up resolutions.

DISCUSSION ON MR. WALDRON'S PAPER ON FINANCING

In presenting his paper Mr. Waldron spoke of the financial protection required by a manufacturer in taking a contract from a foreign government. If it were simply a business firm with no tangible assets in this country, the usual practice would be to have an advance payment to cover the expense of preparation and to insure against financial loss. In turn, the government advancing the money must have suitable security, which might be in the form of a bond. In many cases the hugeness of the contracts had not been fully appreciated and they had been undertaken with a smaller advance than would have been demanded under similar conditions in the conduct of the regular business of the firm. In particular was one contract of $84,000,000 taken with an advance of $10,000,000, which, while it seemed like a large amount, was only 12½ per cent of the total. Later the advance had been increased to $12,000,000.

R. Poliakoff[1] said that Mr. Waldron had mentioned the fact during the presentation of his paper on financing of munitions contracts that a concern had taken a contract for $84,000,000 with an advance payment of only 12½ per cent of the total value. He did not know what concern Mr. Waldron had in mind; but he knew of a similar case of a contract of $84,000,000 and with the same advance payment of 12½ per cent, or $10,000,000.

It was assumed that a contractor who entered into a munitions contract took also upon himself a certain moral obligation, because the equipment of the army depended every day on that contract, and any delay in the execution of the contract became a serious matter. Could a foreign government be blamed, then, when it gave a contract of $84,000,000 and did not advance to the contractor, say, $30,000,000 for which he might ask, especially if the contractor before the war had been rated as a concern with a capital of from one to three million dollars?

Of course, a guarantee for that advance payment could be secured, but how? Well, by surety bonds. But according to the last information of the Treasury, up to August 15, 1916, there were in this country only twenty-six surety companies, with a stock capital of about $27,000,000 and a surplus capital of $20,000,000, making a total of about $47,000,000; moreover, according to the law of this country, none of these companies was allowed to issue surety bonds pertaining to one contract to the aggregate amount of more than ten per cent of its capital and surplus. This meant that even if all the surety companies in the country should pool surety bonds to the largest amount possible, in order to protect one contract, the sum would not exceed $5,000,000. He certainly hoped that in the new contracts some other method of financing and some other method of advance payment would be devised. For it was no easy task to get back money from a contractor who did not live up to his contract.

Again, Mr. Waldron had stated that some contractors had been trying to get contracts even with very small advances, and that these small advance payments must be considered perhaps as one of the reasons why the contractors could not go on. But this was because the contractor could not ask for financial assistance from his bank unless he had the contract in hand. The bank would not give him money unless he had a contract which could be used as a guarantee to protect the bank. Thus the contractor would try to get a contract even with a small advance payment. Therefore small advance payments were by no means the reason of failure of some of the contractors, and the true cause of such failures had to be attributed to different reasons.

Professor Poliakoff, speaking at a later session on Mr. Walsh's paper on The Inspection of Munitions, referred to the points he had made in his discussion of Mr. Waldron's paper for the reason that both writers spoke of the same contract. The Professor said he was authorized by the Russian Government to state that a printed statement concerning Mr. Walsh's remarks was in preparation, which, with the consent of the Publication Committee, would be contributed later to THE JOURNAL.

[1] 111 Broadway, New York. (Assistant Professor of Mechanical Technology, Technical Institute, Moscow, Russia.)

DISCUSSION ON ORGANIZATION, BEARING PARTICULARLY ON THE PAPERS BY MESSRS. COE AND YEOMANS

James Hartness spoke in commendation of all the papers, and particularly of Mr. Coe's contribution on the subject of Organization. He spoke from personal knowledge of the energy, persistence and practicability which Mr. Coe had displayed in reorganizing work for the company with which he was connected, and said that the principles outlined in the paper were worthy of the widest publicity at this time.

H. B. Coho[1] (written), who was in charge of the business organization of the United States Cartridge Company's plant at Lowell, Mass., explained the system of coöperation which they had instituted. Their working force had been increased from 300 to 8400 in considerably less than a year, and their output from 100,000 a day to 2,000,000. They were fortunate in procuring the coöperation of the machine builders, and in having a man in their mechanical department who was not only familiar with cartridge manufacture, but also had a big enough vision to see what would be required so that orders for supplies could be placed ahead.

The company was favored by having available for its work an intelligent class of operatives, who realized that success or failure rested almost solely upon them. In appreciation of their special efforts the company introduced many factory betterments, such as free medical attendance and examination, restaurant facilities, rest rooms for the women workers, first-aid and safety-first. Great attention was paid to a welfare committee, which was organized from among the workers themselves. The labor department, through which all of the 7700 odd people were procured, took the trouble to show the prospective employees the advantages they would derive in this plant over those to be derived from manufacturing plants in other locations.

The services were secured of a great many young men who had been educated as efficiency engineers at the Massachusetts Institute of Technology. The firm had found the difficulty with efficiency men to be that they had cure-alls for everything which they discovered to be wrong, but comparatively little original experience on which to base their experiments. They were, therefore, told that it was not a case of providing medicine for a sick institution, but rather an opportunity to take one department and organize it so it would be synchronous with all the other departments and form a useful cog in the wheel. Results spoke for themselves, as it was now one of the best organized small-arms-manufacturing plants in the United States.

One thing that contributed to the success of the organization was a system of conferences of the various shop committees.

[1] United Lead Company, 111 Broadway, N. Y.

The meetings were conducted along parliamentary lines and a competent stenographer was always present.

A. B. Reynders[1] sent a communication endorsing the statements in Mr. Coe's paper and outlining briefly a method used by his company in the manufacture of high-explosive shells, which secured a large and continuous production after the equipment and operating force had been organized. The method embodied the following features:

1 Piece-work system of wage payment to machine-tool operations. This contained a differential factor; that is, the price per piece increased with an increased output.

2 A liberal bonus system to the supervisory force based upon the following:

a Quantity output

b Expense

c Man efficiency—that is, the ratio of the workmen's earnings to their day rate.

3 A load or bogey set at the beginning of each month for

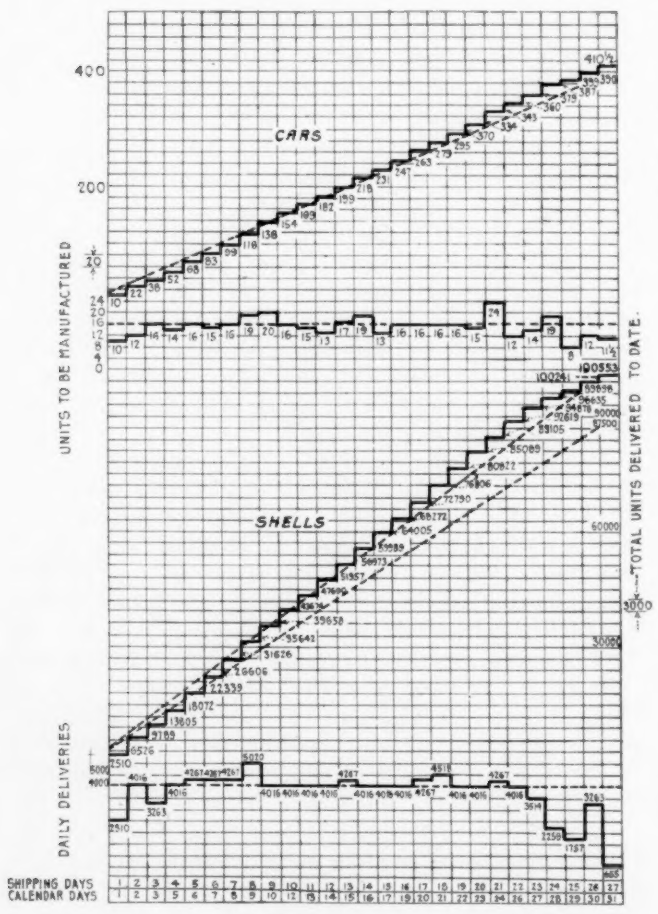


FIG. 1 8-IN. MARK V BRITISH H. E. SHELL

the desired output for that month. This bogey was shown as a diagonal line, as drawn on the accompanying chart, Fig. 1. Each day's output was charted in a step curve.

If the corner of the step touched the diagonal line, production was up to requirements. These charts were fastened to boards and distributed throughout the factory where they could be seen by all of the supervisory force. When the output was satisfactory, the common expression was that they were " hitting the line."

[1] Director of Production, Westinghouse Electric and Manufacturing Company, East Pittsburgh, Pa.

4 In addition to the visible charts for keeping a record of production, a tabular record by operations was maintained. This was reviewed each morning by the manager or superintendent. Any abnormally low output of any operations was immediately checked to see if it was temporary, and if permanent, corrective measures were applied. It was found that this check has to be kept up continuously, as a failure to do so usually settled into a chronic lack of results.

5 An adequate supply of material had to be maintained for continuous production. This meant a large storage space, careful checking with the suppliers of materials, transportation companies, and frequently manufacturing the material by the company itself.

H. G. Bertram wrote giving an account of the organization of the plant with which he is connected (the John Bertram & Sons Company, Ltd., Dundas, Ont.) for the manufacture of 8-in. British howitzer shells. Their regular line of work is machine tools, but the organization for the manufacture of shells is entirely separate.

Upon receipt of their order, the major operations were outlined and the production expected per machine at each stage. Orders were then placed for the necessary machinery and the dimensions of machines secured to which it was expected to fit attachments. As the lathes were purchased without special equipment, great perseverance and close application to the smallest details were required so that the lathes would be ready to run when put under the belt.

Their working gages were made in their own shop from blueprints supplied by the Imperial Munitions Board. When these were ready and the equipment was fitted to one machine in each operation, a shell was carried through at once to see that everything was satisfactory and the finished shell produced was up to standard. Minor changes were made, and half a dozen forgings carried along to see that no failure was likely to crop out. During this time other machines were being installed, and by the time the fixtures had proved satisfactory a start was made on a larger scale.

Following then Mr. Coe's paper, the organization, wrote Mr. Bertram, is made up as follows:

1 GENERAL SERVICE DEPARTMENT:

a Records and Accounting. This is a bookkeeper's work. The shop is charged with components received and credited when shipments are made. In addition, a record is kept of the disposition of all the shells in each heat. The necessary records are sent in from the various departments, such as receiving, shipping, inspecting, etc. The value of these records should not be underestimated, and all information regarding the shells should be carefully filed.

b Purchasing and Stores. The former is handled by the regular shop staff, while the latter is under a special clerk, who checks all shipments coming in and going out and sends a report to the Accounting Department.

c Designing and Drafting is still looked after by the department that got out the tools and fixtures, but with a much reduced staff.

2 DIPLOMATIC STAFF:

This is a very necessary department and is handled in our works by the sales engineer. Quite often the members of the production or engineering staffs are so worried by a breakdown or other troubles that they have not the time to give visiting officials or manufacturers the proper attention. Our sales engineer actively coöperates with the Engineering Department in outlining the machining operations and equipment, and is in a position to give all the necessary explana-

tions. In this way visitors are entertained without interfering with production.

3 Production Department:

a Maintenance of Equipment. Orders for repairs are handled by the original Engineering Department, as they are directly in touch with the various designs, and know whether or not a broken part should be strengthened. They also have the necessary tracings or drawings.

b Operation of Equipment and Training of Workmen. The operations were subdivided into seven small sections (this has later been reduced to six), and placed at the head of each section is a mechanic drawn from the regular shop force. These men are paid a good salary and bonus on shipments, and it is their duty to teach the new operators, many of whom never ran a machine before, to keep the heats running through in order, to watch their machines for failures and check them frequently with indicators to insure perfect work. They are also encouraged to keep a notebook and jot down anything unusual about any of the work going through their department.

c Establishment and Operation of Wage Payments and Penalties Systems. The piece-work system is introduced as soon as records could be figured on. The prices set are fixed for the first order only. Each man is handed a slip daily showing what he earns, so that all errors can be immediately corrected.

Penalties are established, and, while the price is a small part of the cost, it tends to make the workmen more careful.

4 Inspection Department:

The Chief Inspector is chief inspector in the machine-tool department. He looks after the Operation Inspectors, checks all gages frequently, sees that the sub-foremen correct promptly any errors in workmanship which might develop, and, being a first-class mechanic, he keeps generally in touch with all branches of the work.

Operation Inspectors receive the shell after each operation, and, after gaging, stamp their mark after the operator's letter or number. Their report at the end of a run is used to check the operator's production cards. They are instructed to insist upon "quality" before "quantity."

On the 8-in. shell the rough turners have no limit allowed—the inside boring bars are set in the tool room and are between the mean and the high—while no limit is allowed for finish turning. In this way all the shells are cut to the same length over all, instead of weighing each and then cutting to suit.

In many other cases the limits allowed the workmen are reduced.

An inspector goes over the shells before the Government preliminary inspection, and also before the final Government inspection. The final shop inspector has the only shop scales used on the 8-in. shells, and it is a rare thing to find a shell over or under weight.

A special inspector, called the Steel Inspector, watches the forgings, especially after rough turning, for seams or cracks. In this way defective forgings are cut out immediately. The Steel Inspector sends a "defective" record to the shop stores clerk, who checks the shells into the yard and sends the records on to the Accounting Department, where the number of defectives is charged against the various heats appearing on the record.

Discussing Mr. Yeoman's paper, Mr. Bertram said that the greatest difficulties to be encountered by the prospective shell manufacturer were lack of appreciation of the magnitude of the work and lack of organization. The average manufacturer could not hope to equip and bring a large plant up to capacity in less than five or six months. In his own plant, after having practice on two smaller sizes of shells, they prepared machines, tools and gages for 8-in. shells, and thought they did very well to make shipments in about four months after receipt of order. Continuing, he said:

"The statement that an entire plant can be erected, fitted up and operated to capacity in sixty days is most unusual, and would call for explicit information regarding deliveries of material which, unfortunately, is lacking. The feat might be accomplished if one were able to command all avenues of supplies; but being dependent, as one is, upon so many different concerns, each one of which is being held up in turn for want of raw material, strikes and other troubles, one might well cry that it is impossible.

"However, the present war should not require the establishment of such mushroom factories as outlined by the author. There are already many shops fitted for the manufacture of shells, and thousands of others with their organizations, money and machinery, ready to place all at the disposal of the Government; and I truly believe that these shops, with their loyal following, will be able to handle the munition work more economically than shops held together by mercenary officials.

"The type of plant suggested is open to criticism. It presupposes the use of machine tools with a single-pulley drive, with the pulley conveniently located for belting horizontally. This brings up the question whether it is easier to erect a building suitable for all machinery or build machinery suitable for all buildings, or none at all. In starting up a shell plant, engineers without previous experience at their command on the particular size of shell under consideration often prefer cone-driven machinery, owing to the greater range of speeds and feeds obtainable (especially by the use of a two-speed countershaft)." As to leaving the machines exposed, Mr. Bertram said "this would be quite satisfactory in summer if it were not too hot or did not rain, but I suppose sunshades could be supplied at a reasonable cost and operators could be requested to bring their own umbrellas."

Ralph E. Flanders offered some information with reference to 15- and 18-lb. shells, which he believed to be authentic. He said: "We have more than enough shop capacity for their manufacture; at least for our own use. The capacity that has been developed for the English and Russian contracts far surpasses the largest possible consumption that our 15- and 18-lb. guns can take care of. For this reason our attention will probably be directed toward the increase of the gun output on the one hand, and, on the other, toward making larger sizes of shells from 4 in. in diameter up."

In reference to the point mentioned by Mr. Bertram in the discussion of Mr. Yeomans's paper that the most valuable single asset of any firm starting or contemplating the manufacture of anything was its organization, Mr. Flanders said this should be strongly emphasized as a general principle. "This does not mean the paper organization or certain forms and methods of doing business, but the vital organization of a group of men who are used to working together, who know each other, and have a fair degree of knowledge about their jobs. They do not all have to be wonders. They do not all have to be 'top-notchers.' But if they are ordinarily earnest, intelligent men, who have been working together for a number of years, and know each other, they will eventually accomplish more than can be effected by an organization of the greatest group of experts in the country who have never seen each other before."

He was sure that in contemplating work for the Government in this crisis, we must all count on our organizations as being

the most valuable things we could offer to the Government. We should be jealous from patriotic grounds of anything that would tend to break up those organizations in their vital parts.

DISCUSSION ON COÖPERATION AMONG MANUFACTURERS AND THE POOLING OF INFORMATION

The reference by Lieut.-Commander Adams, in his remarks before the meeting, to the coöperation which now existed among Canadian munitions plants, and to their practice of pooling information, led to a general discussion of this subject.

Secretary Rice believed that the point brought out by Lieutenant-Commander Adams in respect to the free interchange of data among Canadian manufacturers was the most important that had developed during the convention. In Canada every citizen not only had a right to go into the plant of every manufacturer of munitions to witness the processes of manufacture, but was cordially invited to do so and if he could improve upon the processes, he was privileged to proceed with the manufacture of munitions on his own account, through the information which he has secured, for the common good of the Dominion.

As President Hollis had emphasized in every way possible,—and in doing so he has been an inspiration to the Society and to the profession,—the supreme effort at this juncture should be for the engineering profession as citizens of the United States to work for the common good of mankind.

William Kent asked if the Government had a bureau to which a manufacturer could apply for information as to the best way of doing a particular machine operation. The case in point was that of a manufacturer doing Government work, who had been experimenting to find out the best way of accomplishing it, but who did not know if the same work had been done before, or if done, by whom it was done.

Lieut.-Commander Adams replied that the proper way to handle such a question would be to take it up with the officer inspecting the material, who would write to the Bureau for the information. If available, the Bureau would inform the company through the inspector where the work was being done, and whether the process could be seen or whether simply a written description of the method would be all that could be sent to the Government.

Reuben Hill, in further answer to Mr. Kent's inquiry, explained the way in which such matters are handled in Canada. He said:

"The Imperial Munitions Board of Canada is organized to create a spirit of 'help one another' among the munitions manufacturers of Canada. Very frequently we have received letters from the office of the Imperial Munitions Board asking us to permit other manufacturers to visit our works and investigate our methods of manufacture. This has been freely permitted, since the Board has explained that the output of a certain number of firms would in any case be required in order to secure the necessary production, and that information given out would in no way affect the amount of work which firms would do individually.

"Prices which the Government pays are known to each of the manufacturers, which still further removes any doubt as to competition. For instance, we have devised a certain tool which has been very useful in obtaining great precision in time-fuse making. Concerns hearing of this, write us asking whether we will send them blueprints of such tool. We make no fuss over it, but immediately mail them the blueprints, at the same time asking them if they require any further information.

"A few weeks ago I had a little doubt as to one of the processes in the manufacture of time fuses. A concern in Toronto very willingly permitted me to send a representative to its plant to inspect the manner in which it performed this particular operation. Shortly afterwards we received a letter from this concern stating that it appreciated the visit of our man and that it would be pleased to do anything for us, and invited us to pay an additional visit. This is the correct spirit to maintain among manufacturers, and, as I stated, this Society should be the main factor in inculcating this spirit in the United States.

"I distinctly remember that at the commencement of our fuse making I paid visits to several concerns. One of the things I was most interested in was the correct formula for the mixing of brass, in order to obtain the necessary tensile strength. It was impossible for me to get any manufacturer to explain his formula, as he considered it a shop secret. To-day there are no secrets at all in relation to this, inasmuch as everybody in Canada knows the exact formula and the way to work the metal. Unquestionably, should this Society start a coöperative spirit of this kind with the Government it would prevent many delays, and, individually, I would willingly undertake to assist the Society in any way with regard to types of machines or designs of tools that would aid in the manufacture of fuses."

Frank O. Wells was in sympathy with the idea of this organization helping the Government and of getting together to supply it with proper information. As he understood it, before war was declared no Government official could add to his force in any way, but the minute war was declared they could not find room enough for the officers in Washington. Thus the Government should have all the help possible from this organization and others similar to it.

Mr. Wells was informed recently by a naval officer in Washington that they had four times the capacity necessary to make shells up to and including 6 in.—four times the capacity of their needs. Whether that was correct or not he did not know, but the officer was in a position to know. Regarding the pooling of information, he was sure that many did not know that the Government had had officers in the different factories gathering data for the use of manufacturers.

Mr. Wells believed that all should coöperate, and that he himself would be only too glad to welcome everybody to his factories; in fact, cards had been issued asking all to come. Instead of each manufacturer experimenting individually, why should not the Government organize a clearing house to serve all manufacturers?

Chester B. Hamilton, Jr., contributed from his experience with the system of coöperation in vogue in Canada. He said in part:

"We were lucky in not having started on the competition basis at all. The shops began by sharing ideas when the orders first began to come through. I think there is not a single shop which refuses information that would tend to increase the capacity of the whole. Any of you who will come to any of our shops in the Dominion will get a thorough welcome.

"I do not know how it is proposed to handle the general contractor question in this country. The larger shops experience many difficulties in doing the work required on fuses, cartridge cases, primers, and the various components of the shells themselves. It is a man's job to look after a shop doing

any one of those things; and the shop where the boss knows the individual will get out delivery ten times faster than a large corporation. In Canada, the Imperial Munitions Board is the general contractor, and buys all the material and turns it over to the component contractors. They make their components and account for the material under inspectors employed by the Imperial Munitions Board. The component parts go, according to the directions of the Imperial Munitions Board, to the various machining and assembling plants, where they are to be worked upon and again inspected and counted, and then shipped on to the loading station, where the fuses and explosives are added. At the loading stations they also receive cartridge cases, primers and propelling charge, and there the completed round is turned out. In short, it amounts to a system of subcontractors, with the Imperial Munitions Board as a general contractor. The plan works out well, because nobody tries to do up somebody else or steal his profit. We are all knit together; it is all in the family.

"As for gages, there are not tool makers enough to make them. We have a few, and the rest are good machinists that are willing to take instructions and be as accurate as the requirements call for. It is the same way in the production department on the munitions themselves. We are running with about two mechanics to a gang, a foreman and a deputy foreman, or instructor; the rest are anything or anybody that we pick up. A good many of them are returned soldiers, wounded men who have recovered from their wounds but are not fit for further service at the front. We see the boys that we worked with last year coming back in pieces. Some of them are able to work at a new trade. We are trying to work them in as well as we can for single operations or repetitional work. Men that are maimed in one member or another can usually be fitted into something within their capacity.

"The first question that Mr. Waldron brought up with regard to the advance payment is not as severe under our method of organization where the Government owns all of the material. We touched the low-water mark, financially, at about sixteen per cent of the value on our first contracts. Size of contracts is unimportant. I do not know how many contracts we have had. It is a continuous system flowing straight through. Anybody figuring otherwise is working on a wrong supposition.

"There is a whole lot more I would like to tell you, but I do not want to go on too long. But wake up, wake up! You are up against a far bigger thing than you have any idea of now. Get the coöperation idea into your head, the idea of working together, not as units or individuals, but all working together."

Ralph E. Carpenter said he personally knew that the Army was working in conjunction with the Bureau of Standards to establish just such a Central Inspection Bureau as had been suggested; and also that the Bureau of Standards was waiting for legislation that would give it increased appropriations. Now it was absolutely tied hand and foot for funds. If this Society should draft a resolution to the proper authorities at Washington that would lead to the appropriation of funds, something would be accomplished which would be modeled after the scheme used in Canada. There would be a bureau for the inspection of gages and the establishment of standards which would assist everybody engaged in the manufacture of munitions.

Mr. Carpenter voiced the sentiment of the manufacturers of this country by saying that they were all willing to coöperate to the fullest extent with every facility that they had at their command, but that the extent to which they would coöperate depended upon the attitude of the Government. At the present time the attitude appeared to be one of competitive bids, which naturally produced competition, but eventually he believed the authorities at Washington who were interested in the manufacture of munitions would work out a comprehensive scheme which would largely eliminate competition.

During the past year the various engineering societies had made every effort to canvass the whole country as to the facilities that were available in the various plants. At the Frankford Arsenal, Mr. Carpenter gathered the impression that they already had a tabulation of all the available facilities and what they could be used for. They were also disposing of some big contracts for the smaller sizes of artillery ammunition. These contracts were being placed with manufacturers who had facilities for doing that work, and eventually they would require the aid of almost every shop in the country.

DISCUSSION ON THE OPPORTUNITIES AND DIFFICULTIES OF THE SMALL MANUFACTURER

E. F. Du Brul said that he had considered the discussion from the point of view of the small manufacturer. In reading different articles dealing with the munitions supply in Europe, he had gathered the idea that practically every machine shop in Germany, Canada, England and France, no matter what its size, had been engaged in making munitions or some war supplies for their respective governments. He had read that many establishments that previously had had no metal-working departments had lathes fitted up in some corner and were turning out shells.

Mr. Du Brul further continued, "It seems from what our Canadian friends said this morning that the smaller shops can produce munitions more quickly than a big organization. In the papers we have had from American manufacturers the contrary seems to be true. The small shop is warned to keep off; but that does not seem to tally at all with the experience in Canada. There the small shops have been turning out large quantities of munitions through coöperation with their manufacturers' association and their shell committees. I think that we ought generally to recognize that in order to help our Government the most, we have first to functionize any activity of this Society along these lines.

"The smaller establishments together employ a great number of machinists and mechanical labor. I remember well that fifteen years ago, when I was criss-crossing the country as Commissioner of the National Metal Trades Association, the man who was quickest to get things done was the man who owned his own business, knew his own business and ran his own business. We always had more trouble with the big organization whose boss was a board of directors than we had in dealing with men who themselves could take prompt action when necessary.

"I take it from talking with others that we smaller manufacturers all want to do our bit, but we cannot find out either what to do or how to do it. It seems to me that we must have talent enough in this Society to work out schemes that would organize these small plants and get their coöperation for national defense. We will never get such schemes from our Government. We must do for ourselves some of the things that the Canadians and British have done.

"Those who heard Mr. Hard talk before the Machine Tool Builders will realize that the British had a tremendous task only to get ready; that they had to eliminate civilian control of purely military matters and eliminate military control of matters of production. The same thing will have to be done here. It is aggravating to think of our Congress wasting time

in providing the lump-sum appropriations which it is the business of Congress to supply. Yet a senator, mechanically ignorant, strikes out an appropriation for gages with the remark that 'gages have nothing to do with the production of munitions.' We, above all others, should do everything possible to eliminate lost motion, waste of time, waste of money and waste of American lives consequent on such stupidity in high places."

Reuben Hill, referring to the previous discussion of the situation of the small manufacturer, said: "I will refer again to the Imperial Munitions Board, which takes a keen interest in the manufacturer, and his progress, and, if necessary, obtains for him any materials or parts, etc., which he is unable to secure promptly. The Board brought over from Great Britain expert ballastic engineers, who are available at any time the manufacturer does not understand certain things in relation to requirements. Should the manufacturer, for instance, in making fuses make a certain hole half a thousandth too large, these engineers are called upon to give their decision as to whether such work is acceptable. Oftentimes, if this deviation does not concern a vital functioning of the fuse, such work may be acceptable, thereby saving the manufacturer considerable expense. Should the manufacturer be temporarily delinquent in deliveries, due to conditions beyond his control, efforts should be made to advance certain payments on his contract, therefore preventing a 'tie-up.' This in turn produces a greater coöperative feeling between the manufacturer and the Government, and at times when the manufacturer would have been forced to quit, he gets sufficient confidence from the relationship between himself and the Government to allow him to overcome what might have been an insurmountable obstacle from his viewpoint.

"Realizing that this spirit of 'give and take' or practical coöperation should exist, it is high time that such methods should be instituted, and, acknowledging that this war is a serious proposition, it is time that all practical information such as described previously should be collated for the benefit of the manufacturer. Broad-minded action, as described above, will oftentimes prevent imperfect work surreptitiously passed through, unknown to the manufacturer, by his own men when percentage inspection is resorted to.

"Any further details in relation to this coöperative action on the part of the British Government I will be glad to furnish if necessary."

M. W. Sherwood, who had been shop manager for a subcontractor of one of the larger concerns making 18-lb. shrapnel, said that the shop had only 250 men, who simply finished the forgings that later were processed by the larger concern, Coöperation between the larger and smaller plants was very satisfactory, although the compensation was not entirely satisfactory. Owing to the poor conditions of business existing at the time, he felt that if some arrangement could be made whereby a standard price could be established and paid; or if the work was taken at a price which subsequent developments proved was lower than the average price paid, if an adjustment could be made to conform to this average, he felt that the small shop would be safe in taking contracts from the large concern, or such portions of the work as they were equipped to do.

F. O. Wells felt sure that the Frankford Arsenal would be glad to give the smaller shops information as to the time required to do the work. He had been there several times and had been very courteously treated.

DISCUSSION OF STANDARDIZATION OF GAGES

Lieutenant-Commander Adams replied to an inquiry as to what provision was being made by the Government for the inspection of different parts required in the manufacture of shells, so that all these would conform to given standards. The Bureau of Ordnance would issue an order on the Naval Gun Factory to manufacture master gages, maximum and minimum go and no-go gages for the shells under manufacture. These master gages would be in charge of the inspector and would be sent to the sub-inspector at the works and be there used by the company having the contract as a model for their gages to be used in the inspection of this material. He said that the Naval Gun Factory had master gages showing the required tolerances, and these gages were furnished to any company manufacturing shells for the Bureau. The company would make their gages from the Government gages, and would have access to the master gages in order to check up their own gages.

Reuben Hill through an endeavor should be made to adopt a scheme similar to that used by the Imperial Munitions Board of Canada, which involves a central gage-checking department. This department should undertake the checking of all new gages which were supplied to their inspectors at the various plants. After checking these gages they were recorded in the Government checking department's office with a serial number and issued to their individual inspectors. They were then checked by a traveling gage inspector, who, in turn, was followed by a checker who checked the references and tested the pieces used by the gage checker. This department should also be able to check any working gages of the manufacturers should they tend to create a dispute as to the accuracy between the manufacturer and the inspector.

Chauncey H. Crawford said the idea of a handbook appealed to him strongly. It should include a list of the necessary tools with description, and information as to where they could be procured, their cost, etc. Similar information should be given upon gages required in munitions manufacture.

Mr. Crawford, who is engaged in railroad work, said that his road had thought of taking up the manufacture of munitions, but after investigation found that their shops did not have a single tool that was fit for making shells of any size. He felt that the question of making guns was a still bigger one and that they were even further away from being equipped for the manufacture of guns than they were for the manufacture of shells. He believed that a committee of the Society should arrange a clearing house of some kind, with an officer in charge, and raise money to pay him. He would personally see that the railroad with which he was connected would join in the undertaking, and would urge other railroads to do the same. To obtain an idea of the strong organization which America now has to contend with, he recommended that engineers read Roberts' Monarchial Socialism in Germany.

H. Wade Hibbard said the question had been raised among the professors of engineering in attendance at the meeting as to whether it would be desirable for the Bureau of Standards to establish subsidiary testing stations at the various engineering schools throughout the country, so that the manufacturer who wanted to have his gages tested would not have to send them such great distances. The professors of the universities, while not expert in testing gages, were expert manipulators, so that they could very easily acquire the touch necessary for the inspection of gages. A large gage manufacturer had told him that he would be glad to have several professors detailed

at his plant to be put under the instruction of a professional gage-tester for the purpose of entering into gage testing.

Reuben Hill, in answer to the above suggestion with respect to the establishment of testing stations for gages, believed that a scheme would be necessary similar to that of the Imperial Munitions Board in Canada. He said it would be readily understood that considerable delay would ensue if the Government inspectors' gages had to be sent to a central point to be checked. If the manufacturer should be remote from the central gage station, it was obvious that the delay would be considerable. Furthermore, the Government inspector, not being in a position to check his test pieces, would not know if his gages were wearing. This referred, of course, to these gages which were being used by the inspector and not to new gages. The latter should be sent to the central checking station for initial inspection and registration under serial numbers for future reference.

COLLECTION OF DATA PROPOSED FOR BENEFIT OF MANUFACTURERS OF MUNITIONS

Ralph E. Flanders referred to the discussion at the Machine Shop Session held in the morning, looking toward a collection of data on the manufacture of field artillery. That was regarded as an open question of great importance, and it was suggested that papers be secured at the earliest possible moment for publication in The Journal.

H. S. Bergen, speaking along the same line, suggested the idea of a handbook which should contain a classified list of munitions and of the various methods adopted by different factories making such munitions. If this information were available in convenient form, it would greatly remove the necessity for visiting factories, in cases where there might be objections raised to visitors coming in from another plant.

F. A. Waldron felt that, if possible, we should get the wheels in motion whereby information which manufacturers seem to demand could be tabulated either in handbook form or in a card index. He thought there might be a clearing house of the college students willing to go into munitions work; of people who are making special types of gages; those who had been manufacturing artillery—or 3-in. shells and down, or 3-in. shells and up. Such information also would be available for the Government.

L. P. Alford said that the work of gathering information on the manufacture of munitions had been done by the technical journals of the country up to the present time. He considered the complete accumulation of data by this means to be beyond the bounds of possibility, but that it might be feasible to organize a bureau with a sufficient staff to accumulate information so that it might be printed in a rather rapid fashion, because a great deal of the information is already in documentary form in the shops which are producing munitions. He believed that the only way to secure the information would be by having a sufficient number of men to canvass the field personally.

H. S. Bergen spoke of the excellent material on the subject of munitions which had appeared in the *American Machinist*, *Machinery*, and the *Iron Age* and other technical journals. He believed it could be more quickly procured through means of these journals than in any other way. He thought that some working arrangement might be had between the different publications and the Government, not in a competitive way, but with each journal working in its own field.

F. E. Rogers suggested that it might be well to get some idea as to what such a work as had been proposed would cost. He, himself, thought that $25,000 would not be sufficient.

Lieutenant-Commander Adams explained the present method of handling the question under debate. While not as satisfactory as the method proposed, manufacturers on several occasions had written to the Inspectors of the Navy in their district requesting additional information, so that they could turn out the material desired; and if the Inspector lacked this information he would request it from the Bureau of Ordnance, and the Bureau of Ordnance would request it from some other district. The information could not always be furnished; sometimes it was not on hand; sometimes it was confidential; but if the inspector of the district did not have it, he would write to the office and they would write direct to some other manufacturer, and thus, under the Government authority, the first manufacturer could quite often get the desired information much more quickly than it could be obtained by waiting for a handbook to come out. There are inspectors at Midvale, Baltimore, Pittsburgh, Bethlehem, Brooklyn, and in Connecticut. The Pittsburgh district covers Buffalo, Cleveland, Toledo, Detroit, Cincinnati and Louisville, and as far west as Alton, Ill. While the Western districts are rather extensive, they have not got the intensive manufacture of munitions in these districts that they have in the East.

In response to the inquiry by John H. Barr as to whether information which the Government had would be given out to the editors of the handbook, in the event of such being prepared, Lieutenant-Commander Adams said that he usually was permitted to give out information. Ordinarily he would have to write to some manufacturer of munitions, or some inspector or bureau for the information, but the Department, at least, would know where to find it and could direct the editor to the proper authority.

F. A. Waldron called attention to the specifications which are sent out by the War Department, to be attached to the pamphlet, giving suggestions as to what materials are employed and their physical characteristics. He had found this very useful in estimating on work, and it would be valuable to almost anybody who should send for specifications and blueprints.

SECOND MUNITIONS SESSION, THURSDAY MORNING

As a result of the discussion at the first session on munitions, a committee was appointed to draft resolutions upon the questions of gages and standards; coöperation among manufacturers in supplying information and the status of men who are serving the country in the industries instead of at the front. These three sets of resolutions were reported at the third session by the committee consisting of: Luther D. Burlingame, *Chairman;* John H. Barr, J. B. Doan, A. J. Baker, Reuben Hill, H. L. Coe, Harry E. Harris and C. B. Hamilton, Jr.

The larger part of the third session was occupied in the discussion of these resolutions, each set being considered

separately, and they were finally approved in the form in which they are given below:

RESOLUTIONS RELATING TO GAGES AND STANDARDS

Whereas: Serious delays have been experienced in other countries and this country in the production of munitions work; and rejection and unnecessary loss to manufacturers and its consequent shortage of labor and material due to lack of control of data and of standard means of measurement; and

Whereas: Great Britain, Canada and France have found standardization of measurement of all war material for both Army and Navy imperatively necessary to obtain uniform and reliable results, and have constructed an efficient organization which has proved successful in overcoming these difficulties; and

Whereas: Increased efficiency of our manufacturers would be promoted by the establishment of proper standards of measurement;

Be it resolved: That the Congress be urged to appropriate sufficient funds for expenditure through a suitable agency, to provide standards and adequate means of calibration, distribution and supervision of such standards; including means for calibration of working and inspection standards in the different centers of munitions manufacture.

Also that provision be made in this appropriation for the establishment of a central office for the collection and dissemination of information on the methods of manufacturing munitions and other supplies.

Resolved: That this Society endorses any efforts tending to promote the ends outlined above, and in view of the imperative needs of the present situation, most strongly urges immediate action.

RESOLUTIONS RELATING TO COÖPERATION BETWEEN MANUFACTURERS

Whereas: It is the patriotic duty of every manufacturer to facilitate and expedite the manufacture of munitions and other supplies for the Army and Navy;

Be it resolved: That an appeal be addressed to all manufacturers and engineers to coöperate in the dissemination of information and the interchange of data pertaining to methods of manufacture, systems of organization, design of tools, operation layouts and time studies, including what is generally known under the term "shop secrets" so far as they pertain to munitions manufacture.

RESOLUTIONS RELATING TO STATUS OF MEN IN THE INDUSTRY

Whereas: It is necessary to obtain the entire patriotic coöperation of every man who can contribute to the furnishing of military and naval supplies;

Be it resolved: That we urge upon the Government the necessity of indicating in some way the value and loyalty of men in service in the industries whose occupation is essential to the production of war supplies.

DISCUSSION OF RESOLUTIONS

In introducing the subject of the resolutions President Hollis said that many other people in this country were passing resolutions to be presented at Washington, as a result of which there were so many lines crossing one another that it would be necessary and desirable before transmitting them to determine whether they would interfere with any action on the part of our Government or by agents representing the Government. The intention would be to discuss them at Washington with the officials there and the Munitions Board, in order to find how effective they would be in bringing about the end which all were hoping would be achieved.

The first set of resolutions, as originally presented, contained a reference to the serious delays which had been experienced in Great Britian and Canada in the production of munitions work, and to the desirability of increased efficiency of American manufacturers "in competition with foreign manufacturers."

Calvin W. Rice, Secretary, suggested that instead of speaking of England and Canada by name, the resolutions should not specifically state what countries it was desired by inference to improve upon, but that the general expression "other countries" be used.

John H. Barr said that in referring to England and Canada we were not reflecting upon them but instead were complimenting them upon the successful handling of a difficult situation. He felt that the resolutions were a great deal stronger with the names of these countries mentioned.

John Platt objected to phrasing the resolutions in a way to indicate that this country was in competition with other countries in munitions work.

Secretary Rice agreed with Mr. Platt, saying that a large number of people in this and other countries thought our entrance into the war indicated the prosecution of a dollar war, which it was not. The President of the United States emphasized in his proclamation that we sought no benefit, direct or indirect, and he felt that the strength of the resolution would be increased by the omission of any term indicating competition, even though we failed to get immediately the results we were after.

Fred H. Colvin said that in presenting resolutions such as was contemplated, the Committee should be appreciative of the condition which existed at the present time with respect to the Bureau of Standards, because of the difficulty which the Bureau was having in securing the appropriation needed for their work. With regard to the gaging of munitions, for example, they were going at it in a thoroughly practical way. Only last week their appropriation for gaging was struck out of the Committee's bill in the Senate, because our learned senators said that gaging had nothing to do with war!

There was some further discussion of phraseology, and a sharp difference of opinion was expressed by several as to whether, when speaking of manufacturers of this country, they should be designated as "*American* manufacturers," or as "manufacturers of the *United States*."

The first set of resolutions was finally approved as printed above.

With respect to the second set of resolutions, there was some discussion as to whether they were sufficiently specific in their phraseology, but they were finally approved as originally presented by the Committee.

The third set of resolutions, relating to recognition of those who sought to serve the country through work in the industries rather than in a military way, led to a discussion of the best way to accomplish such recognition.

President Hollis thought it very essential that recognition be given to those engaged in the industries useful to the country in time of war. For instance, this might be by an exemption board appointed in every state which would issue to persons in the industries exemption cards indicating that the persons holding them were exempt from service in the army by authority of a board duly appointed by the President of the United States.

Frank B. Gilbreth said the day had gone by when the only man to be recognized was one who was dodging bullets. While it might be rather revolutionary from our standpoint, he believed in the method adopted in Germany of a recognized industrial army which wore a designating uniform by which a man's status was determined, rather than by a certificate or by something in his buttonhole.

Reuben Hill declared that American workmen would not wear a uniform, even if they could get it for nothing. The practice in other countries was to give them a button. In Canada girls wear badges with a silver bar for six months' service, for which, after the close of the war, a more permanent decoration would be substituted. The man who returned from the trenches wore a button to show that he had been there, until such time as he received a medal for his service. It was not found possible even to prevail upon returned soldiers to wear their uniforms when they went into the industries.

Mr. Hill further stated that if certificates were issued, they should be endorsed by the concern by which the man was employed, showing his rating and pay. He instanced cases where men had left one firm and passed themselves as experts in seeking employment elsewhere, when, as a matter of fact, they were greatly exceeding their abilities in the claims which they made.

In concluding the discussion previous to the approval of the third set of resolutions, President Hollis said that he had had a hand in drafting them and that they were for the purpose of answering questions such as had been asked him very many times and upon which he had received letters beyond number, to the effect that a man wanted to know if he went into the industries how he could make it plain that he was not a "slacker." He asked who was to indicate to him the relative value of military service and of service in the industries. He had told many young men to stay where they were, doing useful work, but of course that was unofficial and he had no authority for giving such advice. It was his opinion that if there were some Government agency to give such advice officially, it would reconcile those of our citizens who felt uneasy about the matter in cases where they were for any reason exempted from military duty.

F. A. Waldron at the conclusion of the discussion of the resolutions said that because the engineer did not take sufficient interest in political matters, as a general thing he did not figure in public affairs as he should, and often got "the small end of the stick." He thought it would be desirable to outline a plan by which through united effort his services would be sought and his work recognized. With this end in view, he submitted resolutions calling for the establishment of a clearance bureau for information on the manufacture of munitions, which it was voted to refer to the Council of the Society with power.

ADDRESS BY MAJOR P. S. BOND, U. S. A.

Major P. S. Bond,[1] who attended the meeting as a representative of the United States Army, said that he was a civil engineer and not an expert on the subject of the manufacture of munitions, and that he would not attempt to speak upon topics with which his hearers were more conversant than he, but that instead he would refer to certain broad subjects in connection with our entry into the present war.

He said there was a tendency on the part of people entering upon something that they had never done before to go to extremes, to lack a due sense of proportion, to fail to separate the things that counted from those that did not count. He had been in the military service long enough to realize the fact, which he emphasized as the keynote of his remarks, that the spirit which actuated man, the spirit of pride in his efficiency, the spirit of wanting to do things, counted for a great deal more than mere knowledge of details.

During the previous discussion reference had been made to the subject of "slackers," and the status of the engineer who sought service in industrial work rather than in military duties at the front. Commenting on this, Major Bond said that under the voluntary system which had been characteristic of our military policy, or lack of policy, since the early days of our history, service to our country had been voluntary and in consequence inefficient. Now we had done away with the voluntary system and recognized the principle of the universal obligation of the citizens to serve their country—the principle of universal service, which was the only intelligent and efficient plan.

Under the system of universal service there was no such thing as the slacker; he became extinct with the ending of that system. The Government would call the men and select those best suited for military service and the men who were not thus selected certainly were not to be called slackers. They would render service of a different kind. The term slacker, he said, was concomitant with the voluntary system.

Continuing, Major Bond took up the main theme of his address to the effect that his mission was to help his country a little bit by attempting to instill into his hearers the need for the spirit of accomplishment, and the following extracts are taken from his remarks. He said in part:

"I have every confidence in the knowledge of details possessed by the engineers present in respect to the tolerances of the munitions business, the heat treatment of steel, and all such matters. If a man were selected for service in this work, as a matter of course the Government would be interested in the extent of his knowledge of details, but it would be much more interested in knowing whether he had the spirit of doing things or whether he was the kind of man who did not do things.

"To illustrate, there are two kinds of quartermasters in the army. First is the man who is very familiar with all the duties of a quartermaster, the man who knows all the rules and regulations governing just what the quartermaster is supposed to do and what he is not supposed to do; and second, the man who knows comparatively little of the regulations but who goes ahead and does things, because he does not know that he cannot.

"Therefore, unless you as engineers have this spirit of coöperation, or this willingness to do things, your detailed and intimate knowledge of your affairs may be an actual stumbling block to the country. What we ask and need of you is disciplined conduct in the German sense. When a German is asked to do something, he almost automatically does what he is called upon to do, because Germans have been disciplined for generations. The American, on the other hand, has a great deal of individualism; and now is the time when we want to ask him to control that individualism to some extent. When an American is asked to do anything—and this is true of mechanical engineers as well as of all other classes of Americans—he will very often start off by showing that what he is asked to do is absolutely unnecessary; but that if it must be done it better be done in a different way from that in which he was asked to do it. He will then remind one that the business should have been started two or three years ago, anyhow.

"Now we know that we should have started to prepare for war three years ago at the outbreak of hostilities; in fact, that we should have prepared ourselves 30 years ago—but we did not do it! And it is just as much your fault as ours! We

[1] Corps of Engineers, U. S. A., Cleveland, O.

know we have been wrong, but let us get busy and see what can be accomplished to make up for the time that has already been wasted."

Speaking more directly of the war, Major Bond expressed the belief, which he said was common with all military men, that Germany had drawn us into this war with a purpose. He believed that that purpose was to make a separate peace with the Allies at any terms they might ask, provided she were permitted to pursue her conflict with the United States and make us pay every cent that the war had cost her. Continuing, he said:

"The first thing that America must realize is that the country is at war. This may sound foolish, yet what indications is there that we are at war? We see something about war in the newspapers, but we do not realize what the war means because we have faced nothing comparable with it in all our existence.

"Ancient war was fought by a small handful of men trained for that particular purpose. A group of knights from one nation met a group from another nation, and on the outcome of their conflict depended the fate of one or the other nation, all the common people accepting the issue of the conflict because they were not able to oppose the knights.

"How different is the situation of the present day! Instead of a handful of men to do the fighting, war is now a whole nation's game; the entire strength of the nation goes into the conflict, she puts forth every ounce of effort, moral, physical and intellectual. This is well expressed by the title of a recent book, The Nation in Arms. That is what modern war means.

"The science of war is the most complex of all sciences, because it represents the sum of all sciences. There is no science known to mankind, from astronomy to bacteriology, that has not found its application in modern warfare. We are used to big business, but we do not realize that modern war is the biggest of all business.

"The romance, the glittering panoply of the knight and the crusader have been taken out of war and it now has become a matter of cold-blooded business conducted on a strictly business basis and governed by the same laws of cause and effect that rule in all business enterprises.

"In the Civil War some of our greatest battles covered a frontage of five or six miles; today the frontages extend from the North Sea to Switzerland, and from the Gulf of Riga to the Mediterranean Sea. Battles were fought in the Civil War by armies of 100,000 men; today there are millions of men engaged. The modern French '75' can fire 30 shots a minute—as rapidly as the modern rifle; the modern machine gun can fire 1000 shots a minute.

"In the Boer War the British fired about a million shells. Today the Allies on the western front are firing a million shells in a single day. The Frankford Arsenal, working three shifts of eight hours each, can turn out 16,000 shells a day. A single regiment of field artillery (24 guns) could fire this number in one day. A million shells means the product of sixty Frankford arsenals, which indicates the problem that we have before us!

"The dearest hope in the hearts of Americans is the hope of getting something for nothing. We have always sought to evade the issue, and our unearned success has lulled us into a sense of false security. We have hoped that the war could be won by some brilliant invention and without sustained and unwearying effort. All of us have hoped that some one would invent a machine that would save the country from having to send its men to war; but it is my opinion that the way to evade the issue successfully is to be fully prepared to meet it; and it is up to the nation today to put itself in that position.

"The men who have been called from civil life to assist in the mobilization of our industries are hard-headed, practical, common-sense engineers and business men. Their accomplishments, training and standing in the profession entitle them to unqualified support. Mr. Frank Scott, chairman of our Munitions Board, says that the Departments of our Army and Navy are too serviceable to be thrown over and entirely replaced by new civilian bodies. He regards it as the duty of civilians to coördinate the efforts of the Army and Navy and the great industrial forces of the nation.

"Our Ordnance Department has labored long and earnestly, in spite of discouragements, lack of money and popular support. It has labored incessantly, with insufficient funds and insufficient facilities, and yet has kept abreast, and a little more than abreast, of the progress of the art of war. Some of the notable contributions to the science of war have been made by our own ordnance experts, both civil and military. Among these are the disappearing gun, machine and automatic guns, the highest-powered guns in the world, automatic pistols, many devices for range finding, etc., etc.

"There have been no new effective machines introduced into this war. The 42-centimeter guns of Germany were in existence before this war. All the weapons of this war, including the aeroplane, were in use in previous wars, although of course they have been developed and brought to a higher stage of perfection in this war." (A voice: "What about the tank?") "There have been a number of devices, including the 'tank,' which I think is an adaptation of the motor vehicle, and the 'flammenwerfer.' These devices can hardly be dignified by the term 'new arms of warfare.' One does not hear very much now about the 'flammenwerfer' and the 'tank'; but he does hear a great deal about the fire of the '75,' which was invented before this war. We need not look for any sudden developments or new machines to save us. If we attempt to discard all the painstaking study of our Ordnance Department and pin our faith on new and untried devices we will assuredly come to grief.

"Our own Ordnance Department has been conducted on a comparatively small scale heretofore; but we must not hesitate to enlarge upon this; reduction of first cost in war times is no economy. A shortening of this war by even a few days means saving many millions of dollars and many valuable lives, including those of our own countrymen; therefore, let us not count the cost if only we can secure results. It is the function of the engineer to take up the military work of our ordnance experts which has been carried on over years of patient study and research, and to put their military methods on a commercial basis.

"I ask the engineer to get out of his head the idea that the ordnance experts of our army are narrow-minded pedants, that we are hidebound, or out of date, that we do not have commercial sense or commercial spirit. We want the engineer to work with us and bring his knowledge, not to confound or to supersede, but to aid ours, and together we will get results.

"A typical instance that will throw some light on this is that of a contract let for the construction of some wheels for artillery gun carriages. The man who secured the contract was an old wheel maker, who had been at the work all his life and thoroughly understood the business of wheel making from the manufacturer's viewpoint. He complained about the specifications, terming them 'foolish.' The specifications

demanded that the tires should be of a certain grade of higher quality steel than he had been using for tires; and he said to himself: 'Those fools up there in the Ordnance Department, fellows that sit at their desks and design these things, know nothing about commercial affairs or about the construction of wheels, and that is why they have made up these foolish specifications, and I am expected to stick to them.' So he came up to the Ordnance Department to complain about it. He said, 'Why cannot you accept such and such a grade of steel for the tire, milder steel than you have specified here? Why cannot I use good commercial standard steel such as I have always used, instead of that high-speed steel that some foolish ordnance expert has put in there?' And the ordnance expert at once pulled out a record of tests extending over a period of five years, to show the contractor that the durability of the steel that the specifications called for was about three times that of the grade of steel which he proposed to furnish, and that the weight called for was much less. And he explained the importance of weight. The contractor was convinced, and he went off and made the wheels according to the specifications.

"Another example Mr. Scott told me of himself. He had noticed that the specifications of the Ordnance Department called for a certain amount of nickel alloy in the rotating bands of certain projectiles in which the English use pure copper. Now the nickel was somewhat expensive, relatively speaking, but the greatest trouble was the time and the difficulty of obtaining the alloy. Mr. Scott went to the ordnance people and asked why they wanted the nickel alloy instead of the pure copper band? He did not take the attitude of the wheel manufacturer, because he had confidence in the Department, but he asked to know the reason why they could not use the copper band. It was explained to him that it would be contrary to the genius of our Ordnance Department, which is as progressive as any in the world; that their ingenuity and skill had been directed toward the development of very high pressures and very high muzzle velocities, so that our guns of any given size were more powerful than the guns of other nations; and that a copper band was not strong enough to stand up under the resulting stresses. 'And now,' said the ordnance experts, 'If we used the copper band it would prevent our following out our plans, and we either must have the alloyed band or else devise a different and inferior type of ordnance.'"

In conclusion, Major Bond said that modern war meant the application of engineering science to armed conflict. It was primarily an engineer's undertaking and was more that of a mechanical engineer than of a civil engineer. He hoped his hearers would get into their souls the spirit of service and prepare to do what they would be called upon to do without argument, without cavil, without hesitation, criticism or fault finding. "You are called upon to help," he said, "to help with all your hearts and souls and to remember how much it means to our country in the matter of saving the lives of our own citizens. The furnishing of an ample supply of munitions means saving the lives of those you love, therefore for your country's sake turn to and do all that you can. Do not count the cost, do not hesitate."

PRESENTATION OF PAPERS ON TOLERANCES, GAGES, ETC.

Following the address by Major Bond, the last four papers of the meeting were presented. These were given either in brief abstract or by title, owing to the short time available, and were as follows:

Procuring Materials for Munitions, C. B. Nolte.

Limits and Tolerances for the Manufacture of Munitions, A. W. Erdman.

Gages and Small Tools, Frank O. Wells.

The Importance of Intelligent Inspection in Munitions Manufacture, E. T. Walsh.

CONCLUDING DISCUSSION

Major P. S. Bond in discussing the paper on Inspection in Munitions Manufacture by E. T. Walsh emphasized the importance of closeness and accuracy in shell manufacture. He said this was essential, particularly since the adoption of the moving barrage, which had been the secret of the success of the Allies on the Western Front. This method of firing was first successfully employed by General Nivelle and was the occasion of his being elevated to the supreme command of the French armies. The idea of the barrage was to advance the range by certain intervals by the clock, so many yards per minute. The infantry followed immediately behind the barrage, so that as soon as the barrage had passed over the space immediately in front of the trenches, the advancing force was ready to jump in at once before the enemy could come out. Formerly they had to traverse a considerable distance after the barrage was lifted, which gave the enemy an opportunity to come out and oppose them by bringing his machine guns into action.

In the use of the barrage it was found that if there was an error in the bursting point of the shrapnel of even as much as 25 yards, it would result in the killing of great numbers of the attacking force; in fact, it was looked upon as inevitable that a certain number of the men would be killed by the barrage, and a sergeant in the English Army describing to an American such a situation remarked that, "Shorts are very annoying, sir, very annoying, indeed!"

Major Bond said that there had been a great deal of complaint on the part of the Allies about shorts in the shrapnel fire and in high-explosive shell fire. He also called attention to recent occurrences of premature or faulty explosions on our armed ships. There had been a number of instances in the Navy, and a great deal of complaint about the imperfect manufacture of shells. Too much importance could not be placed upon the necessity for accuracy in the manufacture of shells.

Major Bond concluded the technical discussion of the session by urging that we be lenient with our War Department, just as we expected the War Department to be lenient with those, in the membership of the Society for example, who might hold preconceived ideas with respect to the production of munitions. It should be remembered that Germany's system of defense had been under way ever since the Battle of Jena in 1806, at which time Napoleon imposed upon Germany the restrictions that caused her to develop her present scheme of national defense, which has proved thus far to be of great effectiveness.

Now we had this war dumped on us overnight, as it were. We had, comparatively speaking, "a tiny little War Department" which simply was not adequate to the situation. It was literally swamped with duties suddenly thrown upon it. Major Bond urged the engineers present to be patient and said that "the one certainty is that we are all going to be called on for service. Whenever the department wants experts along certain lines this Society, or some other society such as this, will be asked to designate the men who can do the work."

GAS POWER SESSION, THURSDAY MORNING

AT the Gas Power Session, held under the auspices of the Society's Sub-Committee on Gas Power, four papers were presented and discussed. Prof. William T. Magruder and Mr. J. M. Spitzglass, both members of the committee, acted as chairman and secretary, respectively.

PROFESSOR JUDD PRESENTS PAPER ON FIRE-ENGINE TESTS

The first paper presented was by Prof. Horace Judd, entitled Test of a Motor Fire Engine, and contained the results of a test of a Seagrave motor fire engine having a 4-cycle, water-cooled, six-cylinder motor, $5\frac{3}{4}$-in. cylinder bore by $6\frac{1}{2}$-in. stroke, 79.3 hp. by A.L.A.M. rating. The motor operated a four-stage centrifugal pump with balanced end thrust.

The maximum capacity was found to be 745 gal. per min. at 122 lb. pressure at discharge of pump, with 2-in. smooth nozzle and 250-ft. hose line with Siamese union. Gasoline used per hour, 0.218 gal. per hp. at rated load.

With coal at $2 per ton (2000 lb.) and gasoline at 25 cents per gal., the cost of producing a fire stream with the motor fire engine is four times that with a steamer. As compared with the horse-drawn engine, the motor engine can reach a fire in half the time, is readily converted from locomobile to pumping engine, is more easily and economically operated, and eliminates entirely the expense of maintaining horses for transportation. Its duty is nearly six times that of a steam fire engine.

A written discussion of this paper was contributed by Claude M. Garland, and it was discussed orally by E. W. Roberts, and the author replied. The discussion follows:

Claude M. Garland stated, in a written discussion, that the motor fire engine, like many other pieces of apparatus, does not depend for its success upon thermal efficiency or fuel economy. The results in the paper indicate, however, a combined thermal efficiency from engine to water horsepower of approximately 10 per cent, which would doubtless indicate a thermal efficiency of engine of something like 20 per cent. This is a very satisfactory performance.

The differences in fuel costs, as shown in the paper, between the steam- and the motor-driven engine are, however, hardly representative of actual conditions. It is seldom necessary to pay 25 cents a gallon for gasoline; eighteen cents is probably an average figure. It is hardly probable that coal suitable for use under the boiler of a fire engine can be obtained for $2 a ton; $4 would probably be more nearly an average figure.

As the fire engine is seldom in operation for more than a few hours a day, the item of fuel cost is undoubtedly negligible when considered with the advantages of high speed in travel, the saving of time in starting, and the elimination of feed and upkeep on horses.

E. W. Roberts[1] pointed out, as a matter of interest, that no horse-drawn fire apparatus is being built today, and none has been for several years. A few steamers are being built, but they are all drawn by gasoline tractors, and these are gradually being replaced. As rapidly as possible, all the cities in the country are installing motors. The motor-power apparatus is rapidly succeeding the horse everywhere throughout the country.

The chairman thought the paper might be considered as a foundation paper, from which to judge future performances of motor-driven fire engines.

Professor Judd, in closing, said it might be well to point out that the unit was operated entirely by the fire department and fireman operators. Those who conducted the tests had nothing to do with the adjustment of the motors or anything else pertaining to the engines. All they did was to look after the accurate measurement of the fuel and the water pumped. The results presented may therefore be regarded as average results for the type of engine tested.

[1] Consulting Engineer, Cincinnati, O.

MOTOR-TRUCK ENGINES FOR LONG LIFE

The second paper, entitled The Design of Motor-Truck Engines for Long Life, by John Younger, was presented by the Secretary in the absence of the author. A brief synopsis of the paper follows:

The problem of long life of a motor-truck engine is not a simple one, on account of the widely varying conditions under which the engine operates.

Long life depends on three factors: Design, manufacturing excellence, and operating conditions.

Design: Under this head the paper summarizes present practice, giving particulars of recommended materials, dimensions of parts, and factors of safety for the several parts of the engine.

Manufacturing Excellence: Workmanship, tolerances, and running tests are considered. For long life the best workmanship is essential.

Operating Conditions: Recommendations for maintaining the engine in first-class condition are given. For long life particular attention should be paid to lubrication, cleaning, inspection and regulation.

Contributed discussions of this paper were received from H. S. Whitten and H. E. Morton, and the paper was discussed orally by E. W. Roberts and Kaufman T. Keller.

F. A. Whitten[1] wrote that he believed that operating conditions had more effect upon long life of truck engines than design and manufacturing excellence combined. The motor-truck manufacturer, unfortunately, had practically no control over the operating conditions. He had applied governors, screens, and other devices in an endeavor to protect his machine from abuse, but drivers did not like them.

Generally speaking, owners had no workable system to determine whether the manufacturer's devices were being used or his instructions carried out. Any investigation along this line was usually of the sort which resulted in locking the barn door after the horse was stolen. A tremendous amount of education of the owner was required in order to attain proper results. The first trucks a man used were frequently condemned as unfit for the service because of the way in which they were operated. We had very little difficulty with trucks in the hands of those who had had previous experience in operating, as such owners had usually already learned their lesson from the results of neglect and careless handling.

As the author stated, "oil and lots of it" was one of the principal features of successful operation. Actual breakages were rare, and lubrication troubles were responsible for most operating troubles and delays.

The carburetor was not usually considered a part of the

[1] General Motors Truck Co., Pontiac, Mich.

engine, but Mr. Whitten believed it should be so considered, as the success or failure of the engine depended upon the carburetor in more ways than was generally recognized. Investigation would show that present-day lubrication troubles were usually intimately related to the carburetor and fuel. That the low-grade fuel generally used today was responsible for many troubles was a fact not generally recognized by operators.

The driver should not be given control over the carburetor adjustment except to a very limited degree. Choking the air supply to produce a rich mixture for starting might be necessary, but forcing the engine to pull its load before it was warmed up might be a very expensive procedure if persisted in. This rich mixture, with present grades of fuel, was almost certain to carry into the cylinders a certain amount of fluid fuel which destroyed the oil and resulted in piston-ring and cylinder wear. This liquid fuel also worked down past the pistons and destroyed the lubricating oil in the crankcase. Not only was the oil spoiled in this way, but the liquid fuel loosened small particles of carbon dust and carried this down into the cylinders and the crankcase, from whence it would be distributed into the bearings in spite of any screens which might be provided. By the use of a rich mixture, either in starting of the truck or by bad all-around carburetor adjustment, it was possible to wear out a motor in a very short time.

The danger of this sort of operation was self-evident to any engineer, but it seemed very difficult to get the user to appreciate the necessity for care of this sort or to believe he was in any way responsible for troubles caused by such operation.

H. E. Morton discussed the lubrication of an internal-combustion engine of the multi-cylinder so-called high-speed class, which, he stated, involves a variety of problems. The conditions were severe, and in most cases the engines received little attention, so that the real successful system had to be reliable, self-contained, efficient and fitted with indicating devices to give early warning of an exhausted oil supply or irregularity in operation.

The three systems most used were full splash, full-forced and a combination of the two. The individual pump and distributor system was seldom employed on modern engines. There seemed to be no special merit in the full-splash system except low cost. The full-forced and combination systems were both good, but the former, properly designed and applied, would give excellent results, and had the great advantage of making possible the highest unit bearing pressures all through the engine. The belief had existed in the minds of some that this higher loading was made possible by a sort of counterbalance equal to the oil pressure, but there was little to substantiate this theory. "Forced volume system" might be a more significant name for the system, as tests indicated that it was the volume of oil forced through the bearings which was most important. The volume of oil rapidly carried away the heat generated, immediately replaced a break in the oil film, due to momentary heavy loading, and thus allowed the use of very high unit bearing pressures. All the above-mentioned systems made use of what might be loosely termed splash for cylinder-wall lubrication.

To make any one of these systems practical it was necessary to use the oil over and over, passing it through suitable filters each time, of course. Also for ordinary-duty engines all the oil was carried in the lower part of the crankcase. These conditions meant that a great deal of loose carbon was washed into the oil, and as it was so fine that the ordinary wire gauze would not remove it, the pump continued to pass it through the system. This particular point should not be lost sight of, for the carbon particles were quite effective as a lubricant and tended to hold up the viscosity of the oil. A good mineral oil under such conditions appeared to lose very little in lubricating value after long use, especially if occasionally well filtered.

For exceedingly-high-duty engines, such as those designed for aeroplane service, the practice of carrying all the oil in the crankcase was questionable. Oil temperature needed to be kept down, and with a secondary external circulating system and supply reservoir it could be fully controlled. Actual service tests covering many months showed that good oil could be used almost indefinitely, employing an external circulating system and carrying very little oil in the crankcase.

E. W. Roberts[1] said one or two points in the paper were rather astonishing to him, and quite against his experience. A clearance of cylinder and piston of 0.002 in. was generally considered by manufacturers far too large. He believed that such large tolerances were a mistake, because the workmen were apt to get careless. He had never heard of a tolerance for a cylinder or piston of over 0.001 in. He thought that while larger tolerances could be allowed, but tolerances of 0.0005 in. made the men more careful.

He disagreed with the author's contention that spiral oil grooves would be found preferable for bearings. He said that one of the greatest mistakes made by manufacturers of engines of all kinds was in the shape of the oil grooves in the bearings. Experiments made at Cornell by Bierbaum nearly twenty years ago, showed that the proper form of oil groove was the H-groove and not the spiral groove or the X-groove. In engines having lubrication troubles, or hot bearings, if the change were made from the spiral to the H-groove the trouble would generally disappear.

Referring to the general idea that carbon was produced by the lubricating oil, this speaker said that it was not generally recognized that an over-rich mixture was quite a prolific source of carbon, because in such a mixture there was a tendency for the hydrogen to combine with the oxygen; that was now proved experimentally in a number of ways. But the general idea prevailed that all carbon was due to lubricating oil, which is not altogether true.

E. E. Keller discussed the author's statement that "When the oil gets dirty, say, every three hundred miles or so, it ought to be thrown out and replaced with clean oil." In his experience in the testing of engines, he had found that the oil could be used over and over again. It was not necessary to filter it, but by running it through a cream separator the heavier particles of matter that had accumulated in it could be taken out, and the finer carbon or graphite was very beneficial to the engine. He had found, however, that oil used over and over contained considerable muck or gummy substance, which collected in the bottom of the oil can, and which was sometimes due to water getting down and breaking up the oil, or particles of dirt getting in.

Regarding tolerances for cylinder and piston, he differed with the author, and thought that pistons on the high limit should be put into cylinders on the high limit, and pistons on the low limit into cylinders on the low limit.

MR. YOUNGER REPLIES

Mr. Younger, in his closure, said that Mr. Roberts had stated that the clearance of 0.002 in. was generally considered by manufacturers far too large. He did not understand where he got this impression, as in dealing with motor-truck engines of 4 to 5 in. bore, a *maximum* variation in clearance

[1] Consulting Engineer, Cincinnati, O.

of 0.002 in. could be allowed, and it was certainly inadvisable to come below a clearance of at least 0.003 in. on the skirt of the piston; preferably, in accordance with his experience, 0.001 in. per inch diameter of piston.

He thought that in Par. 42 he should have been a little more careful in explaining exactly what was meant by a process of selection. It simply meant, however, that while cylinders could be ground to a maximum tolerance of 0.002 in. and the pistons finished to a similar tolerance, a total tolerance of 0.004 in. should not be allowed in the engine, but that, as stated, pistons on the high limits should be put into cylinders on the low limits. This held for the rest of the engine as regarded connecting-rod bearings, etc.

If Mr. Roberts would refer to the paper, he would see that on connecting-rod bearings the bearings should be grooved with a slightly spiraling oil grove, to prevent ridges wearing on the crankshaft. This was not at all the figure 8 oil groove that probably Mr. Roberts was thinking of, but was simply a one-revolution spiral of a pitch very slightly in excess of the width of the groove. This had been found in combination with labyrinth checks to be exceedingly satisfactory. The H-groove was, as far as he knew, obsolete in automobile-engine practice. Quite a number of firms were using successfully no grooves at all.

He feared that he would have to disagree with Mr. Keller entirely. Oil at the rate of one gallon every two or three hundred miles was so cheap that it should be thrown away, and filtering or separating need not be resorted to.

It must be remembered that the great majority of motor trucks were running in places where mechanical separators could not be easily obtained, and it was very questionable if the labor and cost involved in separating a gallon a week would be worth the trouble. Experience had distinctly shown, beyond all question, that the safest, most reliable way was to throw away oil every two or three hundred miles and replace entirely with clean oil.

Mr. Keller gave away his case entirely when he stated that he noticed considerable muck or gummy substance accumulating in the bottom of the oil pan. This was due to water getting into the oil and products of combustion; also, in cold weather the rich mixture that was used in the carburetor, to get the engine warmed up, would cause an excess of gasoline to drain past the pistons into the oil, and accordingly waste the oil.

Mr. Whitten rightly emphasized the point that operating conditions had a great deal of effect on the long life of truck engines. Designers and manufacturers had still to go a long way in order to make their machines fool-proof against even the most stupid operators. However, in all fairness to truck drivers, it must be stated that the last two or three years had seen very considerable improvement, and the average truck driver today was a reasonably intelligent operator.

DESIGN OF GAS ENGINES DISCUSSED BY MR. DuPRIEST

A paper entitled The Relation of Port Area to the Power of Gas Engines and Its Influence on Regulation, by J. R. DuPriest, was then presented.

In this paper it is stated that any system of connecting up the governor of a gas engine to the throttle valve which gives equal changes in port area for equal changes in the governor speed, will make the regulation of the engine very sensitive at light loads and too slow at heavy loads.

The object of this paper is to present a method of determining the port area required for any fractional load on a throttling gas engine operating on the four-stroke cycle, and to suggest a means of admitting the fuel so as to get the same degree of speed regulation throughout the full range of load.

The author has made an extended study of the working of a $16\frac{1}{2}$ x 24-in. horizontal double-acting tandem throttling engine, running on natural gas at 180 r.p.m., and from a consideration of the data obtained in tests and the characteristic curve of the governor used has devised a method by means of which the relation between the travel of the governor collar and port area for a given power can be determined. A governing mechanism may then be designed which will give equal changes of load for equal movements of the collar, or the ports may be so shaped that equal changes in governor-collar travel will give equal movements of the valve, but at the same time give the proper port area for equal changes in power delivered.

THE PROBLEM OF AEROPLANE-ENGINE DESIGN

The fourth and last paper of the session was that by Charles E. Lucke, entitled The Problem of Aeroplane-Engine Design.

The paper resolved the engine into a light, high-tensioned steel structure, consisting of seamless tubing and forged or welded steel parts, possibly formed in drop-forge dies. To this steel stress structure are added certain members, such as the piston, exhaust valve and guide, designed primarily for heat-flow conditions and not for stresses; and certain closing members, such as the ports for the intake and exhaust, which can be very properly cast in aluminum; and the oil crankcase closure, which can be made of any material desired.

This paper was presented by the chairman, who called attention to its salient points in the following words:

"Professor Lucke prepared this paper from an analytical point of view, and discusses the things which have been done and the outlook for the future whereby to reduce the stresses and decrease the weight per horsepower of aeroplane engines. He states that the air-cooled motor has entirely failed in comparison with the water-cooled motor, which will impress everyone. He considers the mixture quality of very great importance, and also the dryness and the homogeneity of the mixture. He brings out a point about the position of the spark plug, to the effect that the moving of the spark plug from a side wall to a center point will improve the power of the engine. He emphasizes the desirability of using the air meter for measuring the quantity of air supplied and regulating the horsepower. He advocates large diameters and short strokes for aeroplane motors. He states that cast iron is well enough to use, but we now have several methods of making aeroplane-engine cylinders in aluminum or sheet steel or of steel forgings, with cast-iron liners. He discusses the question of the arrangement of cylinders and valves. He takes up the construction of valves, discounts Grashof's formula, goes into the thermal capacity of valves and pistons, particularly, and advocates that the piston head should be made increasing in depth towards the wall of the cylinder to furnish a better means for the heat to pass off."

Written discussions of this paper were contributed by R. C. Carpenter, O. C. Berry, Claude M. Garland, H. L. Hornung, H. E. Morton, E. W. Roberts and H. M. Crane. Mr. Roberts presented his discussion in person.

R. C. Carpenter said that Dr. Lucke's paper should be read in connection with a paper by Neil MacCoull, Jr., presented before the Society of Automobile Engineers in June 1915. The two papers were in remarkable harmony on the principles

of design which applied, and the possible results which might be obtained, in the selection of materials.

The particular problems which had made the production of the aeroplane engine more difficult than internal-combustion engines for marine and stationary purposes were, without doubt, due to the important requisites of reliability, lightness, and efficiency, which requirements were conflicting to a greater or less degree, making it essential that the designer decide which requisite was to be considered the most important.

The question of reliability involved lubrication, carburetion, and all the problems relating to continuous operation. So far as Professor Carpenter could recall, there was no other class of engine in which the question of reliability was so vital for results. In the marine or stationary engine, failure of the engine to operate merely required repairs or adjustments which, although possibly inconvenient, could be made without endangering the entire supporting structure; this was obviously not the case should for any reason the aeroplane engine fail to run.

The use of a compression rod for valve openings was undoubtedly not theoretically correct, but it was giving good satisfaction in practice. The use of a tension rod or steel wire as suggested did not prove so attractive after the necessary mechanism was laid out.

Regarding valve timing, for high-speed engines he had closed the inlet valve as late as 45 deg. past the outer dead center. The best test of the inlet valve was the "flow back." A good plan was to set the valve closing so late that a slight "flow back" from the carburetor would be manifest and then reduce the lap just a few degrees.

In the matter of valve lifts, an increase in the number of valves permitted reduction of lift and reduced both the pounding and the inertia of the mechanism.

In his thermal analysis of the valve, the author had undoubtedly overlooked the flow of heat from the valve head to the seat. The exhaust valve was on its seat about two-thirds of the time, and experience had shown that if the seat was not cooled, valve trouble was experienced.

A misconception had existed among designers regarding the two functions of the piston. Professor Lucke pointed out the heat conduction. Another thing was the wearing surface. Short pistons and shuttle-shaped pistons—pistons with the bearing only on the ends—had insufficient bearing surface, which resulted in rapid wear and a piston slap early in the life of the engine.

A heavy piston was a very bad feature in a high-speed engine. We must keep our piston weights down to reduce the inertia effect. This was very essential.

Regarding the bolts for the cylinders, in his first aeroplane-engine design, made in 1910, he used long cylinder bolts passing through and beyond the crankshaft bearings.

In both papers steel was recommended as a substitute for cast iron, which was obviously a desirable change so far as the substitution might be practicable. In this connection, it would also seem to be of advantage to employ aluminum alloys as far as they proved themselves to be serviceable and reliable both because of the light weight and of the higher heat-transmission coefficient which such alloys had as compared with cast iron.

It was Professor Carpenter's opinion that the aeroplane engine was now passing very rapidly through a development period, and that a short time only would be required to fully disclose the essential requirements as to types, materials, and details of workmanship. These, he believed, would in a general way agree with those stated by Dr. Lucke.

O. C. Berry, in a written discussion, supported the author's point of the importance of motor efficiency and the part which quality of the mixture played in determining this efficiency, by giving the results of tests carried out in the laboratories of Purdue University for the specific purpose of showing the effect on the performance of a motor of changing the character of the mixture.

These tests showed that the most efficient mixture coincided almost exactly with the theoretically perfect mixture when the engine was running under load, and was considerably leaner than the most powerful mixture. For low-load conditions, the richer, more powerful mixture seemed to be more efficient as well, probably due to the fact that it fired more regularly at low pressures.

The tests also showed how very important it was that the mixture be correct if high efficiency was to be obtained. In this connection it was important to note that any change in the temperature of the air or the fuel flowing through the carburetor, or a change in the altitude, would change the character of the mixture furnished by a carburetor having a fixed setting. For this reason the carburetor should be furnished with an adjusting device which could be operated from the driver's seat. By such a means the mixture might be kept correct while the machine was in the air. The rule for the operator to follow was to make the mixture leaner until the engine lost power, and then make it richer, a little at a time, until the power was restored. The leanest mixture with which the engine would pull satisfactorily was the most efficient.

Professor Berry did not agree with Professor Lucke that drying the mixture was a sure cure for carbon in the cylinders. A dry mixture might be too rich and cause a heavy carbon deposit.

The aeroplane motor, like the racing motor, was designed to do most of its running at a speed and torque which were nearly constant. The best way to speed up the rate of combustion in such a motor was to increase the compression. The racing motors developed their best torque at about the speed at which the aeroplane motor was required to run, and gave their best power at nearly twice this speed. The rate of combustion and piston speed were therefore scarcely controlling factors in aeroplane-motor design.

The factor which limited the speed at which an engine could run continuously at full torque was the ability of the bearing at the lower end of the connecting rod to keep cool enough to permit proper lubrication. This was borne out by the experience of automobile-race drivers. An examination of the experience of several hundred cars entered in various races showed that many more engines failed due to crankshaft and connecting-rod trouble than due to piston trouble, and that valves did not cause half as many failures as crankshafts. To Professor Lucke's list of pistons and valves he would therefore add that the connecting-rod and main bearings on the crankshaft must be designed primarily for heat dissipation. The best way to accomplish this was to supply them with a copious supply of oil under pressure, and thus oil-cool them.

Claude M. Garland wrote that there were two points in the paper which his experience would indicate to be of first importance, not only in the design of aeroplane engines, but also in the design of all internal-combustion engines of the single-acting type. These were the design of the exhaust valve and the piston from the standpoint of thermal conductivity for the purpose of maintaining the temperature of these parts at such a degree as to prevent preignition of the charge.

The piston was the more difficult member to handle, and in most instances was the principal offender in premature-ignition

troubles. This was clearly illustrated in the testing of a single-acting engine which had given considerable trouble from pre-ignition. On removing the plate which carried the spark plug immediately after a test, the piston was found to be at a low-red heat. Some experiments were made on this engine for the purpose of determining to what extent the temperature of the piston affected on the premature ignition.

A small nozzle was located in the end of the cylinder, and an injection device provided whereby a very fine stream of water was discharged on the piston head on the opening of the exhaust valve. This not only cooled the piston head, but also the exhaust valve and the cylinder walls. In fact, sufficient water was injected to lower the temperature of the exhaust gases to about 500 deg. fahr. Under these conditions, illuminating gas, which normally could not be compressed to over 70 lb. without premature ignition, could be compressed to 250 lb. without any trouble whatever from this cause. The maximum pressure of the cycle approached 900 lb. per sq. in. Under these conditions the engine indicated a thermal efficiency approaching that of the Diesel.

While it was not possible to provide water injection for the cooling of an aeroplane engine, yet it was possible, as Professor Lucke suggested, to minimize greatly the troubles through proper design of piston and valves for the rapid conduction of heat.

H. L. Hornung wrote that Professor Lucke's analyses of the mixture question were fundamental with any fuel, but became particularly apropos with fuel having end points 400 deg. fahr. and above.

His conception of the straight portion of the m.e.p. curve was no doubt borne out by the inaccuracies of our testing methods, wherein small variables made it impossible to read slight changes in ordinates which must exist, producing a peak in the curve at some maximum point. It did not appear to be a mathematical probability that we should actually have a straight portion to the curve, which was the resultant of variables of a higher than first degree. Of course, for all practical purposes it might do no harm to consider a portion flat, but for the sake of future deductions, it appeared more satisfactory to think of the curve as seldom being straight at any point or series of points.

The author's discussion of arrangement of cylinders and jackets suggested a thermoanalysis of the motor by dividing it horizontally into layers ½ in. in thickness, and laying out a curve with the layers as abscissæ and as temperatures ordinates in different horizontal-vertical planes. Such an analysis would open the eyes of most of us to a new realm of design, and would show why valves do not seat and pistons seize with apparently no reason. It would also show how far the crankcase might be brought up on the cylinder, which might be made with separate heads. Block cylinders failed through our lack of knowledge such as this analysis would give.

Later in the paper there was further evidence of designing from the thermal-stress standpoint. Without desiring to take issue with the author, laboratory investigations showed that heat flow was from the center of the valve to the seat and up through the stem, if the area was sufficient. Here came the question of stem diameter from the standpoint of heat conductivity and not wear. In valves running under high output there was a dark annulus on the outside corresponding to the conducting ability of the seat. The wider the seat, if it seated well, the cooler the valve and the wider the annulus; but the wider the seat the greater chance to catch carbon and the lower the effective area for a given lift. These were shop observations which did not seem to check the analysis of the text. A valve head did not always receive the same amount of heat on the outer edge, nor was the water cooling of the seat always uniform, all of which caused unusual distortions.

The author's thermal-stress analysis of the piston was a masterpiece. Attention should be called to the fact that the center of the piston head usually gave the trouble and controlled largely the cylinder bore for high outputs.

Thermal analysis of the cylinder illustrated the necessity of neglecting the lower regions of the flame-swept bore while giving unusual attention to the regions of the exhaust valve and spark plug. The tendency of this treatment was to bring about a more uniform temperature throughout the cylinder structure.

Sections on the design of the crankcase were certainly worthy of the attention of all engine designers, both from the thermal and dynamic standpoints. Most crankcases were deplorably weak, even in otherwise well-designed engines.

In closing, it seemed proper to accent the tendency so aptly crystallized in this paper of reverting to the fundamental conception of the fact that the internal-combustion engine was a heat engine and must be designed with this primarily in mind before the dynamic designing was done. This course had seldom, if ever, been followed in the past, but was the direction toward which real progress must be made.

H. E. Morton wrote that the paper stated that the ordinary aeronautical-engine piston today was a failure, and was, with the possible exception of the exhaust valve, a source of greatest trouble. While this might be true of some engines, he had for several years been having absolutely no trouble with pistons, and especially those of the aluminum variety. The problem of heat conduction through the piston was unquestionably of great importance, but he found that it was a comparatively simple matter to design a strong, light and also cool-running piston for even comparatively high-speed engines.

It was interesting to note the reference to the use of wire for actuating the valves. He supposed that was one of the first suggestions that came to the mind of a designer, but his experience had been that to incorporate neatly such a member was not a simple matter.

It seemed that Professor Lucke, for some reason or other, had omitted to mention the detachable-head design which was apparently growing in favor in aeronautical work. This design was certainly most convenient both in manufacture and field work, and was especially applicable in connection with aluminum cylinder jackets. The method mentioned in the paper of screwing steel sleeves into the aluminum was more or less expensive and troublesome, and a much simpler method could be resorted to where a detachable head was used. Aluminum heads with cast-iron valve seats were proving very satisfactory, and with a light steel sleeve shrunk into an aluminum casting this detachable-head design became extremely light-weight and accessible.

E. W. Roberts[1] wrote that the air-cooled motor was still a considerable factor in the aeroplane, and for certain classes of machines, like the fast scout, was still in considerable favor. So far as the 2-cycle engine giving way to the 4-cycle type was concerned, this would warrant the assumption that the 2-cycle was the original engine. The majority of the 2-cycles that have been offered for aeroplanes have been poorly constructed and poorly designed. The trouble with this type of engine was not so much with the type itself, but with the builders. It offered a solution of one of the most annoying problems of the aeroplane engine, the trouble with the valves. From 24

[1] Consulting Engineer, Cincinnati, O.

to 25 hours of cumulative flying was about all that could be depended upon from the 4-cycle aeroplane engine, and then it had to be overhauled, the valves reground and all adjustments remade. This phase of the problem had been prominent since the beginning of aviation. Lubrication had been fairly well solved, but in a rather complicated manner, in the 4-cycle type. Valve trouble in the 2-cycle was eliminated because there were no valves. Lubrication of the 2-cycle was simplicity itself because the oil was mixed with the gasoline. In actual flying, the 2-cycle had proved itself fully equal to the 4-cycle in all points but one, and that was fuel economy. This was a very important point, but if the same attention were given to the 2-cycle development as had been given to the 4-cycle, this part of the problem would be solved. As it was, the 2-cycle water-cooled motor did not use quite as much fuel as the air-cooled four-cycle for the same amount of power.

In the matter of carburetion, two conflicting phases of this problem were encountered. One was, we must heat the mixture to get perfect proportions, especially with modern fuels, and heating the mixture reduced volumetric efficiency. Internal-combustion engineers did not altogether agree with the statement that the explosion line on the indicator card must be maintained vertically for a maximum efficiency. Some engineers seemed to think that if the explosion line did not bend toward the expansion line, a certain amount of back pressure would be obtained that would cut down the efficiency. Personally, Mr. Roberts had never seen any data to prove this.

In the statement that curvature of the horsepower-speed line was due to a corresponding variation of volumetric efficiency, and also that at some high speed the horsepower-speed line fell before the volumetric efficiency, he would point out that the two factors of inertia effect of reciprocating parts and vibration in mass had considerable bearing on high-speed efficiency.

Regarding connecting-rod length, he had found the limit in practice was 1.8 times the stroke. While this would undoubtedly appear quite short to some engineers, it apparently gave good results.

He had used quite a number of cast-iron cylinders for aeroplane motors 1/8 in. thick, and had never had any trouble with them. There were several references in the paper to the use of aluminum for water jackets, and apparently for the combustion space. As a matter of interest, he might say that he had built something like 100 aeroplane engines with aluminum-alloy cylinders, and found that when making very extended flights with inadequate radiators these cylinders would break through in the combustion space. In all other respects they gave very satisfactory results.

Regarding valves, and particularly valves in the head, quite a number of engines had been made with a single valve opening into the cylinder which would admit of a very large area. There were several ways in which a single valve opening could be employed.

In conclusion, a feature of aeroplane-engine design that appeared to be overlooked by quite a number of designers was the crankshaft. There were two factors in this connection of great importance and yet quite frequently neglected. One was the length of the crankpin bearing and the other was the securing of lightness by using a hollow shaft. To replace a solid shaft 1⅝ in. in diameter, he used a shaft 2½ in. in diameter with a 2¼-in. hole. This not only decreased the weight to such an extent that a four-cylinder shaft 40½ in. long weighed only 17½ lb. when finished, but the large diameter of bearing reduced the oil-film pressure and practically eliminated overheating these bearings.

W. H. M. Crane, in a written discussion which will be published in full later, outlined the relative characteristics of motors for aviation service and for motor-car service respectively. Regarding the aeroplane motor, he wrote that the one supreme requirement was that it should have the lowest possible weight per horsepower of continuous duty. The weight must include not only the motor and its ordinary accessories, but also the fuel and oil required for the length of flight desired. The limit of power that could be successfully used in aeroplanes had not yet been nearly reached, but already even the lower-powered machines had motors more powerful than all but a few motor cars, while the other military types of aeroplanes employed motors of a power entirely unnecessary in any motor-car service. The bulk of aeroplane motors would have piston displacements of 500 cu. in., or over, while there were very few car motors as large as 500, the average being from 300 to 400.

Not only must it be able to operate continuously at full load without distress due to overheating or other troubles, but it must also have as nearly as possible 100 per cent of reliability. This latter requirement was always present, due to the danger involved in a forced landing at some place unfavorable to landing.

It did not have to be particularly quiet, in view of the very considerable propeller noise. A very moderate amount of muffling of the exhaust and practically no attention to mechanical quietness would meet all the requirements.

Extremely long life in hours of operation, without repair, had not yet been required of aeroplane motors, although the time would undoubtedly come when this feature must be given more serious consideration.

Flexibility, as we knew it in the motor car, was not required in an aeroplane power plant.

Absence of vibration was of importance in aeroplane motors, but as only one full-load speed had to be provided for, the problem was considerably simpler than it was in motor-car engines.

In the aeroplane motor, the lightest possible materials were used, aluminum alloys and the higher grades of alloy steel being very largely employed; cast iron, which had given such valuable service in the gas-engine field, was out of the question on account of its weight. The design, as a whole, should be compact, and the number of parts as small as possible. Only in this way could light weight be obtained with the necessary strength and stiffness. Therefore many motors of the V-type or of the radial type were seen, such as the rotating air-cooled motors and the stationary Salmson motor. Block casting of the cylinders where possible was also a great help toward stiffness with light weight.

Efficiency in gasoline economy being so important, as well as power with light weight, the highest possible compression was employed, while valve-in-head motors were almost universally used. Valve timing, inlet pipes and carburetors were laid out with a view to the best possible operation at the full-load speed desired. Ignition systems of only the highest quality were required to furnish the necessary reliability, in view of the high speeds and continued high temperatures. Magnetos were subject to continuous heavy vibration, and must be built accordingly, while spark plugs had to meet conditions of high temperature and oil that were rarely present in automobile work. Complete oil circulation under high pressure, with special means for cooling the oil, was required to take care of the lubrication under the severe conditions imposed. At the present time, reliability of operation required complete duplicate ignition systems.

Mr. Crane concluded with a consideration of the question of aviation motors driving propellers direct and those driving them through gears. The fundamental basis of power in a gasoline motor was, of course, piston displacement. There was, therefore, always the incentive to increase the number of revolutions, with the idea of getting the greatest possible amount of power out of a given size of cylinder. We were, however, considerably limited in the possibilities of power increase by increased speed, due to the fact that the power could only be expected to increase in proportion to the speed, while the stresses in many of the parts increased as the square of the speed. Furthermore, as the life of many parts subject to repeated stresses limited the reliable life of the motor, increased speed imposed other difficulties of design.

The principal reason for gear-driven propellers was, of course, the well-known limitation of propeller design, based on the speed of the aeroplane. This limitation in aviation work was exactly similar to the limitation in motor-boat work, which had resulted in many high-speed hydroplanes having propellers geared to run at greater speeds than the driving motors. In aeroplane work, the improvement in motor design had tended to outstrip the possibilities of the propeller to such an extent that aviation-propeller speeds were uniformly lower than aviation-motor speeds, except in very-high-speed machines or in certain types of motor. This was especially true because of the military development of aviation, which naturally placed efficiency of operation ahead of long life.

The great advantage of the direct-drive machine, from the point of view of design, lay in the use of the crankshaft as a propeller shaft also, a manifest economy in material, both in the shafts themselves and in the bearings required.

All the studies that Mr. Crane had made indicated that a geared motor must weigh from 15 to 25 per cent more than a lower-speed ungeared motor of the same piston displacement. The question was whether we could get a corresponding increase in horsepower to offset the increased weight. Personally, he thought the question was still a very open one, so open, in fact, that he expected to see both types of motor continued in use for some years to come.

E. W. Roberts pointed out an error in one of the discussions, namely, that the motor should be run at the weakest mixture at which it could operate. That would result in heating the motor and blowing off the radiator.

PROFESSOR LUCKE'S REPLY

Professor Lucke, to whom the discussion was later submitted, wrote that there was practically nothing for him to say in reply except that he was pleased at the acceptance of the ideas set forth in his paper.

INDUSTRIAL SAFETY SESSION, THURSDAY MORNING

At a professional session held under the auspices of the Sub-Committee on Protection of Industrial Workers, tentative drafts of two safety codes were presented and discussed. Howard P. Fairfield acted as chairman of the meeting.

The first code, entitled Tentative Draft of a Code of Safety Standards for Industrial Ladders, included sections on definitions of ladders, general requirements for ladders, fixed ladders, portable straight ladders, extension ladders, fire ladders, portable step ladders, scaffold ladders, trolley ladders, sectional ladders, and safe practices for ladders.

This code was presented by William A. Viall and was discussed orally by Hollis P. Porter and J. G. Hatman. Written discussions were contributed by H. W. Mowery, H. M. Elder, M. W. Alexander and W. F. Wettling.

J. G. Hatman asked whether, when the Code was prepared, the Committee had consulted the work of the National Safety Council on Ladders, which had been approved by the Board of Underwriters in Chicago. Practically all the industrial plants, he said, were using that code as a standard now, and were having it approved by the Board of Underwriters.

Mr. Viall replied that all the codes he knew of followed the National Safety Council idea. In some cases it might be modified somewhat, but not to any extent.

W. F. Wettling,[1] in a written discussion, described a patented form of ladder designed to be stiff and strong enough at the weak points to overcome the danger hazard, and at the same time to be of minimum weight. This ladder was constructed with semi-tubular wrought-steel braces inserted in the recesses on the inner side of the ladder, and bent at right angles at each end and riveted to the top and bottom of each step or rung. The ladder has been approved by The Industrial Board of Pennsylvania Department of Labor and Industry.

M. W. Alexander thought that a paragraph could well be added in Section 8 under the heading Trolley Ladders, to recommend the use of a suitable locking device which would prevent a ladder from inadvertently moving under a man if, for example, he should be reaching around the side and handling a fairly heavy object. Such a locking device could be readily made and would, he believed, be an added feature in the safeguarding of such ladders.

H. W. Mowery[1] wrote that the question of safety-ladder shoes for portable ladders was one upon which there was considerable difference of opinion among those who should know. His experience had led him to the conclusion that spikes or long, sharp points on the foot of such a ladder were dangerous. The hazard of the spike was regarded as more dangerous than the hazard it was designed to eliminate.

The various types of self-adjusting shoes were, too, not entirely satisfactory. In many plants they were considered as excellent safety devices, while in other plants, equal in number and prestige, they were condemned as causing accidents.

An adjustable shoe must be kept clean, in good condition and not allowed to gum up with grease, etc., so that the abrasive, cork or other anti-slip element would be effective. That was a matter of good housekeeping, proper inspection, etc.

Decided objections were raised against such shoes on the ground that workmen seeing a ladder equipped with them would place it at any angle with the horizontal and expect the shoe to hold, thereby increasing the hazard of a fall and defeating the purpose for which the shoes were intended.

[1] The Bent Rung Ladder and Manufacturing Company, Indiana, Pa.

[1] Safety Engineer, American Abrasive Metals Co., New York.

The objection was also raised against adjustable shoes on account of increasing the weight of ladders already too heavy; but as the weight was increased 2 per cent to 5 per cent, this did not seem valid.

Until a portable ladder was so constructed that it automatically could not be used at an unsafe angle, the statistics of ladder casualties would remain about the same, with only slight reductions on account of better construction and inspection.

H. M. Elder contributed a table giving the specifications for standard ladders employed by the American Locomotive Company. He said that although their standard rung was $1\frac{1}{4}$ in. in diameter, whereas the Code specified a minimum diameter of $1\frac{1}{2}$ in., they had not yet had any failure caused by weakness of the rungs. The spread at the bottom of the ladders which they employed was greater than that given in the Code.

On their work ladders got the most and severest service possible, as men were continually handling heavy material up and down them and frequently standing on them working for long periods. The safety devices used at the top and bottom of these ladders were as shown in Fig. 1.

SAFETY STANDARDS FOR POWER-TRANSMISSION MACHINERY

The second code, entitled Safety Standards for Power Transmission Machinery, contained rules and requirements for the protection of industrial workers from hazards commonly presented by mechanical equipment used for transmitting and distributing the power from the prime movers to the various power-utilizing machines, tools and devices.

This code was presented by Rufus W. Hicks and was discussed orally by Hollis P. Porter and William A. Viall. Written discussions were contributed by W. G. Ashton, C. A. Tatum and H. A. Hale, Jr. The discussion follows:

Hollis P. Porter said that he had always found the dimensions of handrails specified as being of the strength and size of $1\frac{1}{4}$-in. standard-weight pipe. A standard-weight $1\frac{1}{4}$-in. pipe had an outside diameter of 1.31 in., and he would like to know whether that was the size meant in the Code and elsewhere.

He also asked whether the specification "If constructed of structural metal the rails imposed shall be at least equal in strength to $2 \times 2 \times 1\frac{1}{4}$-in. angles," related to just the handrail or to the screen guards which were to protect moving parts of a machine.

In regard to belt guards, he asked what size of angle iron should be used and what relation the size of the angle iron should bear to the span which it covered between its supports.

William A. Viall replied to Mr. Porter that $1\frac{1}{4}$-in. pipe meant $1\frac{1}{4}$ in. inside diameter—ordinary commercial pipe. Replying to Mr. Porter's second question, the clause quoted was under Par. 4; everything in that paragraph applied to handrails.

Rufus W. Hicks replied to Mr. Porter's third question that it seemed to be the general practice throughout the East and in Illinois to use $1 \times 1 \times \frac{1}{8}$-in. angles for erecting guards and that these might be used in practically all cases; but owing to the fact that specifying the strength of the different structural materials was more properly the function of the laboratory, the Committee felt it was not their place to take up some special-sized angle and say that it should be adopted as the standard.

W. G. Ashton,[1] in a written discussion, drew attention to Par. 6, which calls for the construction of guards of structural metal from not less than $2 \times 2 \times \frac{1}{4}$-in. angle iron. He agreed that this weight of material was necessary in a great many instances, but had found that $1\frac{1}{4} \times 1\frac{1}{4} \times$ 3-16-in. angles were sufficiently heavy in most cases. It seemed to him that the medium strength could be reduced materially, with recommendations for heavier construction where necessary. That was the policy pursued by his department, and he had found it worked out successfully, especially, at this time, when the price of structural metal had increased so much.

In Par. 7 a center rail of 1 x 4 in. was called for, and he was not thoroughly convinced that this was a practical proposition. He had been using 2 x 4-in. construction throughout, and found it more satisfactory, because 1 x 4-in., unless carefully selected, was liable to warp and did not possess the strength it should. Likewise, they had found some objection to the 4 x 4-in. post. There were places, of course, where they

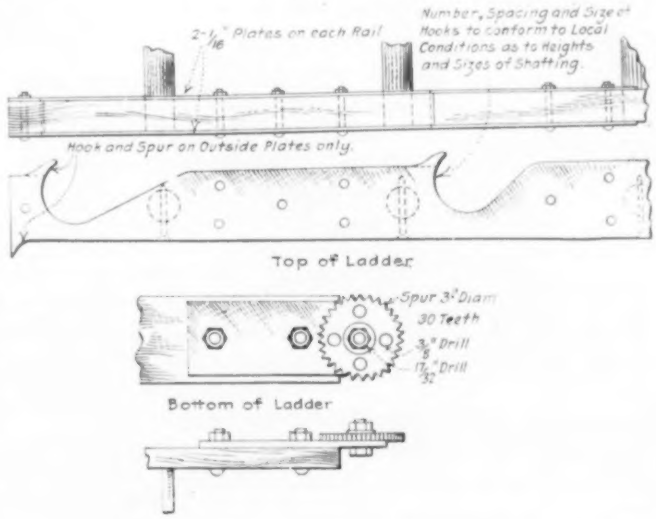


FIG. 1 SAFETY DEVICES USED ON LADDERS BY AMERICAN LOCOMOTIVE COMPANY

used it, but they applied largely the doctrine applied to the angle iron, using 2 x 4-in. construction entirely in many cases. In this connection, he suggested that the cast socket, where wood construction was used, was desirable, especially where it was necessary to remove the guard frequently. Another thing, they had found they should go more into detail, explaining that this type of construction should either be bolted together or fastened together with wooden screws. It made the guards easily removable, and when it came to durability they noticed the effect was very great.

They had found a recommendation as to the construction of angle-iron frames for guards absolutely necessary. So much of this work was squared up at the corners, oftentimes leaving a rough edge, which could be removed either by using a hack saw or an acetylene torch—the latter preferably, because the joint could then be welded, making it very substantial and doing away with the possibility of any rough edges.

In the matter of guarding the exposed sides and bottom, more especially the bottom, of high belts, particularly over passageways, many belts more than 7 ft. from the passageway were especially hazardous unless properly protected, and the notation in the Code on belts over driveways would not be

[1] Commissioner of Labor, Oklahoma City, Okla.

applicable in this case. As an illustration, a belt might be 8 ft. above a runway and yet, should it break, would not only endanger life, but would endanger property as well. No hard and fast rule could be fixed on this proposition, of course, but the matter must be left largely to the judgment of an inspector. It did seem that some specific mention should be made of this particular condition, however.

The application of a guard between the belt and the pulley where the pulley was less than 36 in. from the bearing, he also regarded as inconsistent. The rule was very good where ladders were used for oiling and other work on the shaft, but he did think it could be reduced to approximately 20 in. in cases where runways were used.

In the matter of clutches, he believed that all clutches, wherever located, should be completely enclosed. The same rule should apply to them that was applied to set screws, and this same doctrine applied, in his judgment, to a majority of couplings.

The one problem that they had to contend with was the matter of protecting horizontal shafting. A condition in

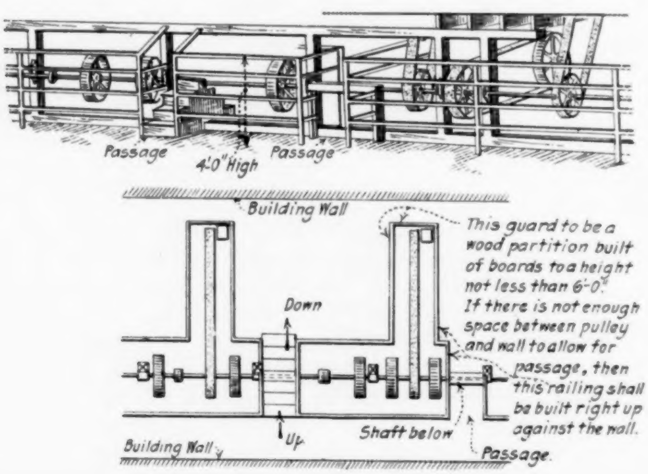


Fig. 1 Guards for Gin Lineshaft

cotton oil mills and gins made it almost impossible to apply standard guards as specified under Classes A and B, and handrails must be relied upon to eliminate the hazard. In a cotton gin, for instance, the lineshaft would be in the basement and approximately 40 ft. long, with some 12 or 14 pulleys, averaging about 30 in. in size. The pulleys would all be equipped with idlers, and to place a handrail with a standard clearance of 5 in. from points of contact would make it impossible for the oiler to get to the bearings from the outside of the fence; likewise, belting one of the pulleys through a fence of 15 in. would be a very cumbersome job.

The common thing had been to put a gate at the edge of the fence or handrail, and the oiler, and others who had some operation to perform along the shafting, went down between the handrail and the moving parts. In fact, the belting was done from there and in many cases there was a tendency to crawl through the handrail and go under or over the shaft as the case might be.

Experiment with this proposition had shown that the belting and the oiling could be done from outside the guard, provided it was placed about 8 in. from the points of contact of the pulley. In fact, the gin men and the oil-mill men said that they belted with more ease following this method. To overcome the feature of crawling through the fence, it had been constructed 48 in. high, and made with four rails instead of two. Through this operation, all the serious accidents that had been occurring in the State in years past had been eliminated.

Argument had been advanced that this guard could be built around the pulleys, but too much care could not be taken about constructing as little of this mechanism around the shafting as possible. For this reason, they did not like the idea of building around each individual pulley; then, too, this reason did not apply in the case of overhead runways, and it seemed inconsistent to require it on ground-floor shafting. Fig. 1 showed their method of guarding a gin lineshaft. At the passageways the guard had to be closed up where the pulley was closer than 15 in.

He thought it would be beneficial to specify the weights and grade of filler to be used. Employers invariably allowed their economy ideas to prevail, with the result that galvanized wire mesh and things of that kind of very little weight were used. This has had a disastrous effect, because of lack of durability, damaged parts causing raw edges. They were now specifying 18 gage steelcrete with $\frac{1}{2}$-in. mesh, or 13 gage with $\frac{3}{4}$-in. mesh, or diamond wire mesh of these weights and sizes, with very good results.

Specifications along construction lines should be incorporated in the specifications in Class A and B guards. Employers should be cautioned to construct the guards so as to leave the bearings outside the guard, and where this was impossible, the bearings should be tapped and equipped with extension oilers, extending outside the guard. Again, special caution should be given that where these close guards were made, doors full length of the guard, allowing the employees access when necessary to make repairs, should be provided. To further carry out this idea of repairs, where it was necessary floor sockets should be provided so as to make the guards easily removable. These sockets should be not less than 16 in. deep, with $\frac{1}{4}$-in. walls and a $3\frac{1}{2}$-in. base $\frac{3}{8}$ in. thick. On this point, in dealing with food-producing establishments, stress should be laid upon the necessity of leaving one side of this socket open so as to afford cleanliness. Also it should be specified that the filler, where used on $1\frac{1}{4}$-in. standard pipe should be constructed on an independent frame of not less than 1-in. channel iron secured to the iron pipe in a substantial manner.

A thing that seemed to have been overlooked in the specifications was a standard upright guard in front of high-speed belts at passageways, and this applied particularly at floor passageways. They had used two types of guard for protecting this, one type being iron pipe of various dimensions, setting it in concrete in the floor and extending it to the ceiling or supporting it from the wall back of the guard. Another was to use angle-iron frames filled in with very heavy sheet metal or boiler iron. In one plant the generator belts were protected with 4-in. iron pipe set in 3 ft. of concrete, using five pipes in front of each belt. These belts broke frequently, and the guard served as a perfect protection. In other places of lighter belts of less speed, they were using the angle-iron frames.

C. A. Tatum[1] wrote that it was important that standards be defined on conditions effecting the safety of machine operation, and also for the purpose of arriving at a fixed basis or practice for insurance purposes as well.

The matter of friction drives had also been overlooked in the Code. They were using a complete enclosure for this

[1] Manager, Safety Department, Texas Employers' Insurance Association.

type of drive, made on a frame of 1¼ x 1¼ x 3-16-in. angle filled in with 18-gage ½-in.-mesh expanded metal, or 20-gage sheet metal. This was the general type of guard. In other cases they were using a band guard of cast iron extending clear around the friction and flanged down on both sides beyond the points of contact. They were using 16-gage metal in most cases, reinforced with ½-in. strap iron.

Another thing they had found almost imperative was that solid enclosures for couplings, dead-shaft ends and things of that kind should be independently supported so as not to revolve with the moving parts. Where these guards were so constructed that they revolved with the moving parts, they created a hazard in themselves.

Referring to Par. 11, the insurance rating schedule took no consideration of the speed of the belts, charging for a 2-in. hack-saw drive the same as a 42-in. counter at 7000 ft. per min. and making the same requirement in each case. Belts over a certain weight and speed could not be protected by the ordinary guard from the dangers incident to breaking, but this danger would rather be increased in the event of a break by the presence of either woodwork or fabricated steel used as a guard; and it was his opinion in cases of this nature that the standard handrails, properly located, should be employed instead of trough guards or housings. A condition prevailed in the South in cottonseed-oil mills, of which there were a large number, where the drive of the attrition mill using two 8-in. belts to disks moving opposite it, required 8-in. belts at about 7000 ft. speed, and in which the most practical method of protection would be to use the hand rails shown in Fig. 44, of the proposed Code. The trough guards or a solid enclosure would increase the hazard on account of the necessity of a number of employees always being engaged in the vicinity of the machine.

With regard to Par. 29, set screws employed to secure pulleys could not be of the safety type, and it was necessary that exceptions be made in cases of this kind; but it should be required that a cover be used, which might be either of a turned wooden block properly secured, or a leather strip wound around the hub to the height of the screw, and made secure.

Referring to Par. 39, an effective signal system should be required in all plants where machinery was in group drive, and fixed rules should be established for the use of these signals. Negligence on this point had caused a large percentage of the serious accidents in the industries. The compensation rating schedule took no cognizance of a signal system, but it was his opinion that in many plants the importance of a well-laid-out signal system, with defined rules of operation, was such that it would be entitled to a substantial credit on the plant. It should carry about the same value as the stop-and-start device or ten-machine limit on group drives. Par. 34, should be a companion charge or credit, with a stop-and-start device on machinery.

Par. 40 dealt with an important feature in any plant, and it should be made requisite that the same record of inspection of improvements be kept on transmissions as on the individual machines.

Henry A. Hale, Jr.,[1] recommended the following changes in the Code to make it harmonious with the safety standards now recognized by practically all companies writing workmen's compensation and liability insurance throughout the United States:

Par. 2, Line 2, to read: "Guarded part is less than 4 in., etc.," the assumption being that a person's finger cannot project more than 4 in. and become injured, through a substantial guard that will not admit objects larger than 2 in.

Par. 3, Line 2, to read: "Guarded part is 4 in. or more, etc.," this change being explained as above.

Par. 4, Line 3, to read: "Extreme parts within 6 ft. of floor, a handrail 36 in. in height," this standard being recognized by the insurance companies as affording adequate protection.

Par. 4, Line 5, to read: "Supported at least every 8 ft., of substantial and rigid construction, with no sharp points or edges." With this definition it appeared that Pars. 5, 6 and 7 were entirely superfluous. The dimensions mentioned in these paragraphs did not contribute to the effectiveness of the guard unless the work of construction and erection was properly executed. The dimensions of materials used should therefore be left to the discretion of the one who designed or erected the railing.

Pars. 9, 11, 12, 13, 14 and 15 to be supplemented by the following:

"Belts (chain, rope) shall be completely enclosed or effectively guarded. Guards shall be of substantial construction, securely fastened in place and of such size and arrangement that a hand or other part of the body cannot project through, over, around or underneath guard, and be caught at point of contact of belt and pulley, or between spokes and pulley and adjacent framework or other fixed part.

"If the point of contact of belt and pulley is within 6 ft. of floor or platform level, a guard shall be provided, the top edge of which, if higher than the point of contact, shall not be less than 15 in. from such point of contact,[1] but in no case need the guard be higher than 6 ft. from floor or platform, nor shall it be less than 36 in. in height.

"If the top edge of guard is lower than the point of contact of belt and pulley located within 6 ft. of floor or platform shall be considered as standard if consisting of a double railing 36 in. in height.

"If the point of contact of a vertical and inclined belt and pulley is more than 6 ft. above the floor or platform, guard shall be 36 in. in height with the top edge not less than 3 in. nor more than 15 in. (measured horizontally) from the vertical projection of all portions of the belt and pulley within 6 ft. of floor or platform level.

"Where pulleys are of such dimensions and so located as to permit passage between upper and lower part of belt, standard railing shall be provided and a substantial passageway, guarded on sides and top, shall be constructed, or space, traversed by belt, shall be completely barred against passage.

"Overhead belts, with lower part 7 ft. or less from floor or platform level, shall be guarded on sides and bottom, or space underneath belts to be railed off to avoid use for passageway or storage."

It was inadvisable to use a railing for a guard in connection with rope transmission, except in some cases along the sides of a horizontal drive, as in many instances a broken rope had become entangled in a railing guard, causing considerable havoc.

In Par. 11 an exception was provided to the effect that guards were not required on belts "transmitting so little power that accidental contact therewith could cause no accident." This vague expression was very misleading, for he could not conceive of any equipment that would come under

[1] America Mutual Liability Insurance Co., Boston, Mass.

[1] It is undesirable to locate a guard more than 15 in. (measured horizontally) from a moving part and thereby permit persons to get between the guard and danger point.

this caption. For example, a $\frac{3}{8}$-in.-diameter belt on a sewing machine had caused an injury to a female employee costing the insurance carrier $9500 to settle. While he would not recommend that all $\frac{3}{8}$-in. belts should be guarded, yet some definite width or diameter of belt should be expressly mentioned as a minimum where guarding was required.

In Par. 16, if the floor of a wagon was to be considered as a working platform, were we not permitting a railing on wagon floor to serve as a guard in accordance with Par. 15?

Pars. 24, 25, 26 and 27, Mr. Hale recommended, should be replaced by the following substitute: "All couplings within 7 ft. of the floor or working platform or within 36 in. of a bearing shall be concentric with the shafting and guarded as follows: Dangerous projections shall be completely enclosed or guarded in such a manner as will prevent the clothing of persons from being caught thereon."

In Par. 34, Line 2, the words "to stop immediately all power-transmission equipment" were objectionable, and as a substitute the following was recommended: "To disengage the power driving all engine-stop systems." To his knowledge there was no means of stopping all the power-transmission equipment "immediately" or "instantly" without inflicting considerable damage. Reference to "locking in stop position" should be confined to clutches and tight- and loose-pulley equipment.

Par. 41 permitted removal of guards for repairs and adjustments, while Par. 42 stated that guards should not be removed. This inconsistency should be corrected.

In conclusion, he recommended that action in adopting any code of standards for power-transmission machinery should be deferred at this time. There was an urgent need of harmonizing so far as possible, the code that might be adopted by the Society with other standard codes now in force, and it would appear that ample deliberation in this connection would tend to eliminate unnecessary waste and confusion by giving a little more time for careful consideration of the draft submitted.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Departments of The Journal by members of The American Society of Mechanical Engineers are solicited by the Publication Committee. Contributions particularly welcomed are suggestions on Society Affairs, discussions of papers published in The Journal, or brief articles of current interest to mechanical engineers.

Strength of Boiler Furnaces

TO THE EDITOR:

In reply to Mr. H. J. Vander Eb's comments published in the February, 1917, issue of THE JOURNAL upon my communication on the Strength of Boiler Furnaces which appeared in the October, 1916, issue, the point I wished to bring out was the undesirability of a lap joint, and my discussion was leveled at the A.S.M.E. Boiler Code rule only, inasmuch as it permits a lap joint. I would like to see some criticism of the theory I suggested in the August, 1916, issue of the Journal of the American Society of Naval Engineers, on page 729, because, failing that, I maintain that a lap joint in a cylinder subjected to external pressure is far weaker than it has been hitherto supposed to be, and therefore all rules permitting it are bad. Interest centers round the A.S.M.E. Boiler Code rule as being probably the most influential one in the future.

Regarding the points raised by Mr. Vander Eb:

1 *Fairbairn's Rule.* This was taken because of its interest as the parent formula. It is customary to consider this as applying to jointless flues (if used at all). A careful perusal of Fairbairn's original paper prohibts its use for a lap joint. It is true Fairbairn used joints brazed and riveted, but it is equally sure that he regarded them as very different from a conventional lap joint. They were probably spliced joints and carefully brought to a true circle. As proof of this, note that Experiment 23 was an *ordinary* lap joint and that Experiment 4 was a single-strap butt joint. The relative strengths of these two joints were in the ratio 69.3:100.

In using results for the calculation of constant in formula, *Experiment 23 is ignored but 24 is taken.* Apart from this convincing fact, the phraseology often shows Fairbairn's clear conception of the importance of circularity.

I agree with Mr. Vander Eb's criticism of Fairbairn's formula. I think this is generally admitted.

2 *Hutton's Rule.* As this rule is closely allied to Fairbairn's, it is presumably intended for jointless flues (or truly circular flues, which are nearly equivalent), pending more definite evidence to the contrary. The fact that it is sometimes used for lap-jointed flues simply results in a smaller factor of safety than is supposed to exist.

3 Regarding the supposed unfavorable dimensions of the particular concrete case I took, it was the failure of this actual flue, due to buckling just outside the lap joint, that caused me to investigate the action of the joint analytically and, incidentally, to compare a few formulæ.

4 My application of the German Government rule was incorrect. I accept Mr. Vander Eb's correction.

5 I have never found any authority for using Lloyd's rule on lap-jointed flues. The fact that this is done in some instances merely goes to show the need of definite regulations in the matter to prevent appropriation of part of factor of safety.

6 *Board of Trade Rule.* I regret omitting to increase the constant by 10 per cent to allow for steel instead of wrought iron. This, however, will not check with Mr. Vander Eb's figure. My allowing for a single-riveted lap joint was quite correct, as the constant I took was for a double-riveted joint, which necessitated a reduction in the ratio of the supposed efficiencies. The several sources of information I consulted did not give a constant for a single-riveted lap joint.

7 The fact that Boiler Code rule takes into account the full length of the flue instead of separate sections, as some formulæ do, is admittedly in its favor where such conditions exist. Where such conditions do not exist it is rather pointless to argue what would happen if they did exist. Ultraconservatism under one set of conditions is no offset for shortcomings under other conditions.

I wish again to emphasize the weakness of a lap joint. I believe all formulæ which permit lap joints result in giving a much smaller factor of safety than is commonly supposed. I should very much like to see a discussion on the theory I

suggest, as hitherto we have looked upon the action in a lap joint as somewhat obscure from an analytical standpoint and not lending itself to definite analysis.

Until a fallacy in my theory is found I hold the opinion that a lap joint is capable of being analyzed, or at least that we can figure a certain condition that the actual state of affairs is equal to or worse. Moreover, this condition is surprisingly bad.

It is important to note that where a formula does not permit of a lap joint, and an adjustment is made according to the conventional theory for lap joints, as was done in the first part of my A.S.N.E. paper, the results are very questionable. The absurdity of the orthodox theory is grasped when it is considered that if the rivets fill the holes perfectly the efficiency will come close to 100 per cent when the joint is in compression. Actually I have shown that the joint proper may be left almost out of the question, as the weak spot is just where lapping begins. This is a well-known fact experimentally, as the double thickness of the plate remains intact, the buckling occurring just where this leaves off.

John Airey.

Chicago, Ill.

WORK OF THE BOILER CODE COMMITTEE

The Boiler Code Committee meets monthly for the purpose of considering communications relative to the Boiler Code. Any one desiring information as to the application of the Code is requested to communicate with the Secretary of the Committee, Mr. C. W. Obert, 29 West 39th St., New York City.

The procedure of the Committee in handling the cases is as follows: All inquiries must be in written form before they are accepted for consideration. Copies are sent by the Secretary of the Committee to all of the members of the Committee. The interpretation, in the form of a reply, is then prepared by the Committee and passed upon at a regular meeting of the Committee. This interpretation is later submitted to the Council of the Society for approval, after which it is issued to the inquirer and simultaneously published in The Journal, in order that anyone interested may readily secure the latest information concerning the interpretation.

Below are given the interpretations of the Committee as approved by the Council on April 19-20, 1917, in Cases Nos. 146 to 152 inclusive. In this report, as previously, the names of inquirers have been omitted.

Case No. 146

Inquiry: Is it necessary under the requirements of the Boiler Code that pressed steel manhole plates shall be stamped as to the quality of the steel, heat number and tensile strength provided they are ordered flange or firebox steel?

Reply: The rules of the Boiler Code do not specify that pressed steel used for manhole plates should be stamped. The plates to be so stamped are specified in Par. 36 of the Code.

Case No. 147

Inquiry: What is the correct location for the bottom gage cock in a vertical tubular boiler? One-third the length of the tubes above the top of the lower tube sheet is found to be too short for short tubes and too long for long tubes.

Reply: It is the opinion of the Committee that this inquiry is answered by Case No. 86. In the revised Code the fusible plug limits given in Par. 430 of the Boiler Code will be estalished as the lowest permissible water levels for the various types of boilers.

Case No. 148

Inquiry: Will the design of steel handhole cap for use in water tube boilers of the waterleg type, shown in Fig. 7, meet with the approval of the Boiler Code Committee? This cap requires no gasket to make it tight, being inserted in the hole from the inside of the waterleg and expanded from the outside with a special expanding tool, which is also used for the purpose of truing up the holes, making them standard size and slightly tapering from the inside outward.

Reply: The Committee has decided that it will not express approval of any specific construction. Attention is called to the fact that a device of the sort should meet the requirements of Par. 251 which calls for the ends of all tubes, suspension tubes and nipples when not beaded to be flared not less than 1/8 in. over the diameter of the tube hole on all water tube boilers and superheaters, this flare in the present instance to be on the pressure side of the plate. If the requirements of this paragraph are met, there is nothing in the Code to prevent the use of the design, provided the material from which it is constructed meets the requirements in Par. 5.

Case No. 149

Inquiry: Will the arrangement of equalizer pipe for double drum water tube boilers, shown in Fig. 8, meet with the approval of the Boiler Code Committee for working pressures up to 225 lb.? The equalizer is to be made of extra heavy cast iron flanges, the joints in the pipes to be welded.

Reply: It is the opinion of the Committee that this design will not be permissible under Par. 277 of the Code.

Case No. 151

Inquiry: Are cast iron dovetail or slip lugs permitted under the rules of the A.S.M.E. Boiler Code for horizontal return tubular boilers?

Reply: It is the opinion of the Boiler Code Committee that there is nothing in the Code to prevent the use of this type of bracket, provided it is properly designed and conforms to Pars. 323, 324, and 325, and is used only where cast iron brackets are allowed.

Case No. 152

Inquiry: Is it necessary that safety valves for use on industrial steam locomotives, that are not subject to federal inspection or control, shall, if constructed to meet the requirements of the A.S.M.E. Boiler Code, be fitted with the lever specified in Par. 282? It would appear advisable to make the use of the lever optional inasmuch as 70 or 80 per cent of the railroad locomotives in the United States are using safety valves without levers.

Reply: If the safety valves referred to are to be applied to boilers that are to be constructed and inspected under the Boiler Code, it will be necessary to apply the levers and in all other respects conform to the requirements of the Code.

Progress of the Code

Members will be interested to know what progress the Boiler Code has made in the various states, and the following are excerpts from a report made by Mr. Thomas E. Durban,

chairman of the administrative council of The American Uniform Boiler-Law Society, on that question.

NEW YORK

The Code Committee of New York has formally adopted the A.S.M.E. Code and reported it favorably to the Industrial Commission. The Commission consists of the following: John Mitchell, Chairman; Edward P. Lyon, Louis Wiard, James M. Lynch, and Henry D. Sayer. A great deal of the work has been done by Thomas C. Eipper, Deputy Commissioner, and chairman of the Committee on Boilers.

Probably no state will give the matter of the Boiler Code greater care than did the State of New York. The Code Commission went up and down through the state, and then published a tentative code, and went up and down the state again, getting criticisms and comments on this code, pursuing much the same course that the Boiler Code Committee of The American Society of Mechanical Engineers pursued in its original work, but gave the public greater chance, perhaps, to criticize and make suggestions than has ever before been accorded. Meetings were held in Buffalo, Syracuse, Rochester, Utica, Albany and New York, and much interest was developed and much valuable information obtained. It is a great compliment to our Committee that, after all this strenuous work, the A.S.M.E. Code was adopted verbatim.

We have just been advised by the State Industrial Commission of New York that the Commission, at a meeting held June 5, 1917, adopted the proposed rules for boilers in factories in the State of New York, as formulated by their Advisory Committee, effective July 1, 1917, new construction, effective January 1, 1918.

MICHIGAN

An enabling act was passed unanimously by the house and senate, and has been signed by the governor, and a committee will be appointed to proceed with the adoption of the Code.

In all the effort made, the understanding has been that the A.S.M.E. Code would be adopted. It is reported that the Code will not be placed in effect till early next year.

Great assistance has been rendered by Mr. J. C. McCabe, Chief Inspector of Steam Boilers of the City of Detroit; Professor M. E. Cooley, of the University of Michigan; Professor Bissell, of Lansing; Mr. E. C. Fisher, of Saginaw; and Mr. T. H. Hinchman, of Detroit.

NEW JERSEY

An enabling act was passed by the legislature and signed by the governor, the same as in Michigan, and it is understood that in due time New Jersey will issue the Code and announce the date of its going into effect.

The Code will be put into operation under the jurisdiction of Colonel Lewis T. Bryant, Commissioner of Labor. A Board of Boiler Rules has been appointed which consists of three inspectors, Messrs. Case, Scott, and Walker, and two appointees from the community at large: F. W. Casler, Mem. Am.Soc.M.E., representing the boiler users, and Frank Van Winkle, representing the boiler operators.

MINNESOTA

Minnesota has issued a notice through the duly appointed representatives of the Inspection Board of the state, that on and after January 1, 1918, all boilers must be made according to the A.S.M.E. Code. This has been approved by the governor, and renders the Code absolutely effective after the date mentioned.

Much of the credit for the accomplishment of this is due to Mr. Max Toltz and Mr. Oliver Crosby, of St. Paul.

MISSOURI

The City of St. Louis has passed the Code to put it in operation, as has also Kansas City, and it is understood that the City of St. Joseph is contemplating similar action. With the example set by these cities, at the next meeting of the legislature the Code will probably be adopted by the State of Missouri.

COLORADO

The new Industrial Commission of the state will probably have the power to adopt the Code, and the Boiler-Law Society is in correspondence with the Commission at this time.

CANADA

The Province of Manitoba is revising its boiler code, and expects to call a meeting in the near future with the idea of getting the coöperation of the other provinces in Canada, in the hope that a universal rule can be made for Canada. The Boiler-Law Society is in correspondence with the various provinces, and there has been expressed a desire to make the A.S.M.E. Code operative in Canada. In this the Society has the strong support of the Province of Ontario, which is one of the leading provinces in Canada, and also of the leading boiler manufacturers throughout the entire Dominion.

SUMMARY

The states and cities in which the Code has been adopted or is in process of adoption are:

New York	Indiana
New Jersey	Michigan
Pennsylvania	Wisconsin
Ohio	Minnesota

California

Kansas City and St. Louis, Missouri

Respectfully submitted,

(*Signed*) THOS. E. DURBAN,
Chairman.

An American Committee of Engineers has been formed in London which will be glad, among other duties, to give assistance to any American engineers arriving in England on any official business connected with the War. This assistance would probably take the form of offering advice and hints as to saving time in approaching British official departments.

The address of the committee is 6 Copthall Avenue, London, E. C., and the Hon. Secretary is Mr. C. W. Purington.

A memorial fountain has been erected in the old engineering building of Tulane University, in honor of Prof. Henry F. Rugan, associate professor of mechanical arts at the University at the time of his death, September 3, 1916. Mr. L. W. Zeller made the presentation speech on behalf of the students, and Prof. W. H. Creighton, dean of the College of Technology of Tulane University, in accepting, praised the research work on the growth of cast iron by Professor Rugan.

Society Affairs

Engineering Survey

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Executive Committee of the Council

Ira N. Hollis, *Chairman*
John H. Barr
Arthur M. Greene, Jr.
D. S. Jacobus
Charles T. Main
Spencer Miller

COMMITTEES, ETC.

STANDING COMMITTEES

Chairmen

Finance, Robert M. Dixon
Meetings, Robert H. Fernald
Publication, Fred. R. Low
Membership, To be appointed
Library, John W. Lieb
House, Frederick A. Scheffler
Research, R. J. S. Pigott
Constitution and By-Laws, F. R. Hutton
Standardization, Henry Hess

SOCIETY REPRESENTATION

American Association Advancement of Science
American Society Testing Materials, Joint Conference Committee
American Society for Testing Materials, Modification Briggs Standard for Pipe Threads
Classification of Technical Literature
Conference Committee on Electrical Engineering Standards
Conference Committee of National Engineering Societies
Conservation
Engineering Foundation
Expert Testimony Committee
John Fritz Medal, Board of Award
Joseph A. Holmes Memorial Association
Military Engineering Committee
National Defense Committee
Naval Consulting Board of the United States
Standardization of Pipe and Pipe Fittings for Fire Protection
Trustees United Engineering Society

SPECIAL COMMITTEES

Chairmen

Administration, Robert M. Dixon
Am. Soc. M. E. Junior Prizes
Am. Soc. M. E. Student Prizes
Boiler Code Committee, John A. Stevens
Committee on Engineering Resources, George J. Foran
Conference Committee on American Engineering Standards
Conference Committee to Determine Cost of Electric Power, W. B. Jackson
Engineering Education
Flanges and Pipe Fittings
Increase of Membership, A. L. Williston
Joint Committee on Standards for Graphic Presentation, Willard C. Brinton.
Local Sections, D. Robert Yarnall
Machine Tools Standardization
Metric System, L. D. Burlingame
National Defense Committee
National Museum
Nominating Committee, L. E. Strothman
Patent Laws
Pipe Threads, International Standard, Edwin M. Herr
Power Tests, Geo. H. Barrus
Refrigeration, D. S. Jacobus
Research Committee,
- Sub-Committee on Bearing Metals, C. H. Bierbaum
- Sub-Committee on Cutting Action of Machine Tools, Leon P. Alford
- Sub-Committee on Fuel Oil, Raymond H. Danforth
- Sub-Committee on Investigation of the Clinkering of Coal, Lionel S. Marks
- Sub-Committee on Lubrication, Albert Kingsbury
- Sub-Committee on Materials of Electrical Engineering
- Sub-Committee on Safety Valves
- Sub-Committee on Steam Flow Meters, R. J. S. Pigott
- Sub-Committee on Worm Gearing, Fred. A. Halsey

Student Branches, Frederick R. Hutton
Tellers of Election, Robert H. Kirk
Tolerances in Screw Thread Fits, L. D. Burlingame

SECTIONS COMMITTEES

Chairmen and Secretaries

Atlanta, Oscar Elsas, Cecil P. Poole
Baltimore, W. W. Varney, A. G. Christie
Birmingham, J. H. Klinck, J. G. Hatman
Boston, W. G. Starkweather, A. C. Ashton
Buffalo, David Bell (Secretary to be appointed)
Chicago, A. D. Bailey, A. L. Rice
Cincinnati, F. A. Geier, J. T. Faig
Detroit, G. W. Bissel, S. J. Hoexter
Erie, J. F. Wadsworth, M. E. Smith
Indianapolis, W. H. Insley, (Secretary to be appointed)
Los Angeles, F. G. Pease, T. J. Royer
Milwaukee, W. M. White, F. H. Dorner
Minnesota, H. L. Brink, E. A. Wilhelm
New Haven, H. B. Sargent, E. H. Lockwood
New Orleans, H. L. Hutson, E. W. Carr
New York, J. J. Swan, A. D. Blake
Ontario, R. W. Angus, Chester B. Hamilton, Jr.
Philadelphia, L. F. Moody, J. P. Mudd
St. Louis, R. L. Radcliffe, E. H. Tenney
San Francisco, B. F. Raber, C. H. Delany
Worcester, Geo. I. Rockwood, R. G. Williams

[1] A complete list of the officers and committees o the Society will be found in the Year Book for 1917 and in the March, 1917 issue of The Journal.

SOCIETY AFFAIRS

A Record of the Current Activities of the Society, Its Members, Council, Committees, Sections and Student Branches; and an Account of Professional Affairs of Interest to the Membership

EVERYONE is asking what the Society is doing to help the Government. First, a committee, consisting of Messrs. George J. Foran, Chairman; A. D. Blake, Henry C. Meyer, Jr., C. M. Allen and John H. Barr, has issued a personal classification sheet to every member of the society, and the replies are being collated. Already four hundred names of members of the society have been furnished the Government in answer to specific requests from the War Department. This is in addition to the work of the Employment Bureau, through which the Society gives special attention in the matter of placing men in positions in the industries.

Second, the society is an active member of the Engineering Committee of the Advisory Commission of the National Council of Defense, and several meetings have been held leading to definite and constructive assistance in the manufacture of munitions and in foreseeing the wants of the Government in the matter of power.

Third, as has already been stated, many of the members of the Society are serving on the Engineering Committee of the National Research Council, which is maintained by the funds of the Engineering Foundation, and in which this Society is a participant.

Fourth, as a result of the Spring meeting of the Society, a committee has been appointed by the Council, with the President as chairman, which will first investigate and then recommend to the Council how this Society can best assist in the establishment of a comprehensive system of the manufacture of munitions in the United States, including the establishment of a Central Bureau for master gages and district headquarters for copies of those gages, with provision for the comparison of working gages with those copies of the master gages, similar to what it is understood is in vogue in Canada.

The United States must in this present crisis be conducted as one business, with every man, woman and child working to a common end.

In another column are given the appointments on the Engineering Council, and it is possible now to accomplish many of the activities which the engineering profession, as a whole, may undertake. A meeting for the organization of the Council will be called in the near future.

The Society is also in conference with the Adjutant-General of the State of New York, through whose office has been established the Resource Mobilization Bureau of the State of New York, and is prepared to render similar services to the officers of other states in connection with taking industrial censuses.

The Secretary would be pleased to receive suggestions of ways in which the Society can render further service, and also offers of individual services in addition to what may be included in the personal classification sheets just issued to the membership.

CALVIN W. RICE,
Secretary.

COUNCIL NOTES

A MEETING of the Council was held on May 21, in Cincinnati, Ohio, in connection with the Spring Meeting. The following members were present: Ira N. Hollis, *President*, John H. Barr, C. H. Benjamin, W. F. M. Goss, James Hartness, Oberlin Smith, F. R. Low, chairman of the Publication Committee, and Calvin W. Rice, *Secretary*.

Engineering Resources. George J. Foran, chairman, C. M. Allen, John H. Barr, A. D. Blake and H. C. Meyer, Jr., were appointed a special committee on Engineering Resources to prepare a Personal Classification Sheet[1] for the purpose of putting on file immediately, classified data of the membership, to be of assistance in placement activities in the present national emergency.

Finance Committee. Upon recommendation of the Finance Committee, it was decided to subscribe to ten thousand dollars of U. S. Liberty Bonds, taking the necessary money from funds of the Society, even at some inconvenience.

Engineering Council. Five representatives of our Society were appointed on the Engineering Council, as follows: Charles Whiting Baker, John H. Barr, Arthur M. Greene, Jr., Ira N. Hollis and D. S. Jacobus.

Constitution and By-Laws. Amendments to the Constitution and By-Laws as presented by the Committee on Constitution and By-Laws were referred to the Business Session of the Spring Meeting. These amendments deal with standing committees, professional committees, discussion of political matters, and quorum at Council meetings. They will be again brought up at the Annual Meeting.

Joint Committee on Terminology. In response to an invitation from the National Electric Light Association, H. C. Anderson, N. A. Carle and F. R. Low were appointed to represent the Society on an advisory committee on Terminology.

Sections. The following executive committees for the Sections of Baltimore, Indianapolis, New York and Toronto were approved:

Baltimore: W. W. Varney, chairman; L. B. Robertson, vice-chairman; A. G. Christie, secretary; C. C. Thomas, treasurer, and Wm. Chatard, member executive committee.

Indianapolis: W. H. Insley, chairman; L. M. Wainwright, vice-chairman; B. G. Mering, treasurer; F. C. Wagner and L. W. Wallace.

New York: John J. Swan, E. J. Prindle, A. D. Blake, J. H. Norris and W. H. Greul.

Toronto: G. V. Ahara, R. W. Angus, C. R. Burt, L. H. Fletemeyer and C. B. Hamilton.

[1] This form has been sent out to the membership during the past month.

Student Branches. The establishment of a Student branch at Michigan Agricultural College, East Lansing, Mich., was approved.

Standardization Committee. Upon recommendation of the Standardization Committee there is to be appointed a committee on standardization of small hose couplings, other than fire-hose couplings. A committee on standardization of roller chains is also to be appointed.

A.S.M.E. Boiler Code. Interpretations in cases Nos. 146 to 152 were approved and ordered published in The Journal. They are included in this issue.

Calvin W. Rice, *Secretary.*

SPRING MEETING ENTERTAINMENT

THE entertainment arranged by the Cincinnati Local Committees for the Spring Meetings of our Society and of the National Machine Tool Builders' Association, demonstrated alike the inventive capacity and hospitality of Cincinnati engineers. Event succeeded event in almost startling array, and with a perfection of detail such as only a master hand can give.

THE SMOKER

Tuesday evening was "pleasure first" night, with which no one was supposed to allow any duties to interfere. It was the night of the smoker, and, so far as known, every engineer in attendance at the meeting responded to the call to be at the Business Men's Club "promptly at 8 o'clock" to participate. Shortly after arrival the company formed in a procession, headed by President Hollis and F. A. Geier, and was conducted to the large hall of the club by a fifer and drummers, veterans of the Civil War, who portrayed the "Spirit of '76," as well as the spirit of hospitality of 1917. When in the hall the visitors found themselves facing the street of a mining town of the far-western type, realistic in every detail. It proved to be Losantiville, the pioneer settlement from which grew the city of Cincinnati. Here were the early settlers true to life—historic characters, all of them, including the engineer who was to lay out and develop the city that was to be. There was an attack by Indians, and then a peace conference, at which the engineer saved the day by a portrayal of the possibilities of the future for the community. Peace declared, all were invited "inside" to celebrate.

The complete program of the evening comprised 18 numbers. A band played spirited music, and patriotism was cultivated by a quartet in khaki, which sang several national airs amid appropriate surroundings. There was a mock trial, with many unique features, including the musician, who demonstrated that he was an "engineer," and so eligible for jury duty, by playing most remarkably on the one string of a violin which he had constructed of a "cigar box and a broom handle." In this and in the laughable presentation of the Cincinnati plan of education which followed, the characteristics of several prominent members of the profession were portrayed in a way that delighted the audience. The mock trial was preceded by a rapid-sketch artist, who brought into the limelight several members of our Society and of the National Machine Tool Builders' Association.

At the close of the evening, promptly at 12 o'clock, Dr. Hollis was called to the stage and addressed by Chairman Geier, who expressed the pleasure that all Cincinnati members would feel in presenting him with a token of their esteem. Thereupon H. M. Norris, of the entertainment committee, headed a procession for the stage, and bore a large vase to the platform. But alas! as the top step was reached, Mr. Norris tripped and fell, the vase was shattered, and a look of consternation was on every face. Nothing abashed, Mr. Geier stepped forward and said that the committee would now make a presentation of a Cincinnati product, and thereupon gave Dr. Hollis a bit of beautiful Rookwood pottery, a framed plaque representing a woods scene in the vicinity.

A bounteous repast—no mere luncheon—was served during the evening; and at intervals the hall was made beautiful by remarkable kaleidoscopic lighting effects produced by throwing lights against slowly rotating colored balls with myriads of reflecting surfaces.

ENTERTAINMENT FOR THE LADIES

While the men were at the smoker the ladies were not forgotten, for they were asked to assemble in the small ballroom of the Hotel Sinton to witness a performance under the direction of Helen Schuster-Martin, Managing Director of The Little Playhouse Company, Cincinnati. Two plays were given, "The Maker of Dreams," by Oliphant Downs, and "How He Lied to Her Husband," by Bernard Shaw. These were followed by a dancing pantomime.

The ladies' committee, of which Mrs. R. K. LeBlond was chairman, issued a very attractive program for the occasion.

In many ways throughout the meeting the stay of the ladies in Cincinnati was made pleasant for them through their gracious reception by the Cincinnati ladies. For Monday visits were planned to the wonderful new city hospital and to the Woman's Club. On Tuesday was an excursion to Rookwood Pottery and the Art Museum, and in the afternoon an automobile ride to Fort Thomas and tea at Hotel Altamont. Tuesday was styled "Ladies' Day." It was, indeed, a day of pleasure for the visiting ladies.

On Wednesday and Thursday were other excursions, shopping trips, automobile rides, etc., in addition to the events in which both men and women participated.

BOAT TRIP AND AUTOMOBILE RIDES

On Wednesday all went on the *Island Queen* to Fernbank Dam and back, and enjoyed a delightful afternoon. The spacious dancing floor of the large boat was well patronized, and there was an amusing cakewalk competition by three "darky" couples engaged for the occasion, who did the stunt in true Southern fashion. Prizes were awarded according to the amount of applause.

On Thursday afternoon there was a procession of 160 automobiles bearing the party for an afternoon's outing, and, as some one remarked, "Not a 'flivver' among them." Two service automobiles accompanied the party. They were not needed, but their presence indicated the extreme care that was being given by the local committees for every detail. The ladies had had luncheon at the Zoological Garden, where they were met by the men, and from where all went to the Country Club for tea. A considerable number also were taken on rides on Friday afternoon.

VISITS TO SHOPS

For the engineers present, one of the great features was the opportunity of visiting the shops of the city, so many of which

have new and modern structures. The development of these shops in output and in progressive methods during the past few years has been very noteworthy.

As a courtesy on the part of the Lunkenheimer Company, a very handsome souvenir was distributed in the form of a paperweight bearing the American eagle mounted on a flag-decorated standard. Not only was this an attractive gift, but one that interested many because of the refinements of production required in its manufacture.

WEDNESDAY EVENING'S ENTERTAINMENT

The guests who went to the grand ballroom of the Hotel Sinton on Wednesday evening expecting to participate in the usual dance and reception were both surprised and pleasantly disappointed. The dance was held, it is true, but not until a most elaborate entertainment had been given on the ballroom stage. There was a series of finely executed moving pictures of the maneuvers of the Ohio cavalry troop on the Mexican border, besides pictures of Cincinnati and vicinity, and a film prepared specially for the occasion of the Cincinnati Committee preparing for the convention. The finance committee was shown collecting the funds, and woe-betided any wealthy manufacturer who entered the room, for his pockets were instantly rifled and his funds commandeered for the use of the committee. In disbursing the funds, the committee decided after their own manner how this should be done, incidentally pocketing occasional stray dollars.

There were music and professional dancing on the stage, and the entertainment concluded with an elaborate interpretive dance performance by the Goldenburg Players of Cincinnati. This was the portrayal of a fanciful tale in which children largely participated, and drew the enthusiastic applause of the audience. It was the most spectacular performance of the whole meeting, and greatly enjoyed and appreciated.

C. Wood Walter

J. B. Doan, President N. M. T. B. A.

A. H. Tuechter

One of the Pleasant Features of the Spring Meeting was the Association with the National Machine Tool Builders' Association. President Doan and Messrs. Geier, Walter and Tuechter Constituted the N. M. T. B. A. Executive Committee.

Business Meeting at Cincinnati

As usual, preceding the first session of the Spring Meeting was the regular business meeting. The chief item of business was the announcement of certain proposed changes in the Constitution which will later be submitted to the membership for letter-ballot and then will come up for discussion and action at the next Annual Meeting. These changes relate to age limit for junior members; reduction in the number of Standing Committees; change in the number of members constituting a quorum of the Council; provision for an increased number of so-called Annual Committees; etc.

President Ira N. Hollis announced that the Council had voted to invest $10,000 of the Society's funds in a subscription to the Liberty Loan, even at some slight inconvenience; and that whereas the Council alone had authority to do this, nevertheless it was desired to apprise the meeting of this action. In taking this action the Council felt that, as the agent of the entire Society, it was voicing the overwhelming opinion of the membership in its desire to subscribe to the success of what everyone had so much at heart.

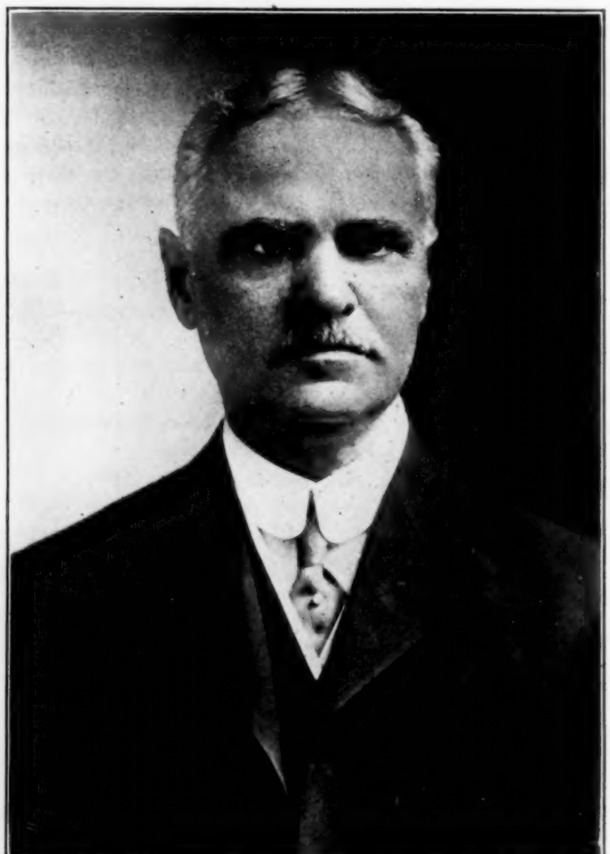
It was further announced by President Hollis that a Committee on Engineering Resources had been appointed, which was about to issue a blank to the membership for the purpose of securing data upon the professional experience of each member and his ability to serve the Government, should the call come for engineers to enter Government service. He said that he believed the country would not make the mistake that England made at the outset of the war by sending her best industrial men to the trenches. While many engineers would go into the Army, and many of the graduates of his own institution, the Worcester Polytechnic Institute, had already gone as reserve officers, he thought every man in the Society ought to do contentedly and willingly the thing that he was best adapted to do.

MAJOR GENERAL GOETHALS ELECTED HONORARY MEMBER

TO the list of illustrious men who have been honored by the Society there is added one more name—that of Major General George W. Goethals, who will go down in history as the builder of our "Big Ditch," the Panama Canal.

The preëminent gifts of "the Colonel," as thousands of Canal workers have known him affectionately during their work on the Isthmus, have been demonstrated in many ways but most conspicuously in two directions—first, in his truly marvelous capacity for mastering and retaining details, and second, in his ability to win the confidence and inspire the loyalty and enthusiasm of those working under him. He is one of those rare persons whose full knowledge of details does not hamper his mental vision. He possesses the one all-necessary gift for successful leadership—sagacity.

Innumerable sketches of General Goethals' life have been written, but the facts and incidents of a great career are always of interest.



Underwood and Underwood.

MAJOR GENERAL GEORGE W. GOETHALS

George W. Goethals was born in Brooklyn, N. Y., in 1858. His was not the carefree life of many a youngster, for at eleven years of age he began work as an errand boy in a broker's office, working after school hours and in the evenings. As proof of his efficiency, at fourteen he was cashier and bookkeeper of a firm. At this time he was studying in the College of the City of New York. His early ambition was to be a doctor, and with this end in view he matriculated at Columbia University; but poor health compelled him to give up this plan. He made a number of attempts to get an appointment to the United States Military Academy at West Point before he was successful. However, in 1876, at the age of 18, he received his appointment, and under the strict régime of that famous institution soon regained his full strength and health. He attained there the three principal honors within the reach of a cadet: he stood second in his class in scholarship, he was chosen as one of the four captains of the cadet corps, and he was elected senior president of his class. He was graduated in 1880, receiving an appointment as second lieutenant in the Corps of Engineers. In 1885 he returned to West Point and served as assistant professor of military engineering until 1888.

He gained his practical experience for the great task of Panama by hard work and tireless energy. Among his most important tasks were the construction of dams, canals and locks at Mussel Shoals in the Tennessee River, and the extensive fortification and harbor work at Newport, R. I. In 1903 he was called to Washington as a member of the General Staff, one of the first engineers to be so appointed.

It was in 1903 also that he was appointed chairman as well as chief engineer of a new commission—composed on its technical side of army and navy officers—for the completion of the Panama Canal.

His work on the Canal is distinguished by its signal efficiency. Everyone on the Isthmus worked hard, but none worked harder than did "the Colonel." He stopped work at night only to sleep, and sometimes, in his own phrase, he "took the Canal to bed with him."

If there was anything more wonderful on the Isthmus than the efficiency of the force that was building the Canal, it was its *esprit de corps.* Everybody from "the Colonel" down and back again believed in the Canal, loved the Canal and fought the great fight that made the Canal a reality. Toward his fellow-workers his motto was, "Be considerate, just and fair with them in all dealings, treating them as fellow-members of the great brotherhood of humanity."

"Tell the Colonel," was the characteristic refrain of a popular song on the Isthmus, and everyone proceeded with his grievance, problem or suggestion to follow that rule. In turn they received ungrudging justice, all-around helpfulness and cordial recognition. The building of the Panama Canal will always stand as a monument of fame to "the Colonel."

In 1913 the degree of LL.D was conferred on him by the University of Pennsylvania. In the spring of 1914 he was awarded medals by the National Geographic Society, the Civic Forum (New York), and the National Institute of Social Sciences. Late in 1913 and early in 1914 he was in demand for various administrative positions, declining the police commissionership of New York City, offered to him by Mayor Mitchel and the "city managership" of Dayton, Ohio. On February 3, 1914, he was appointed by President Wilson the first civil governor of the Panama Canal Zone. By act of Congress, March, 1915, he was made Major General. On June 11th of this year Rutgers College conferred on him the honorary degree of Doctor of Science.

Though appreciative of all his many honors, General Goethals is unusually averse to having any public recognition made of his work, and finds his greatest satisfaction in the completion of what he set out to do.

Just recently, in April of this year, General Goethals agreed to supervise the building of ships authorized by Con-

gress to be built under the United States Shipping Board Emergency Fleet Corporation. In view of the National call upon his services he has been released by Governor Edge of New Jersey from his contract to supervise the $15,000,000 expenditure for reconstructing the highways of that state.

General Goethals' success is due to a few broad, solid and simple principles, at the base of which lies the quality of loyalty. He believes profoundly in action and in taking responsibility. He believes that the sense of duty to one's self and to one's country should be the incentive to achievement—not the hope of reward either in profit or fame.

Formal presentation of the "diploma" of honorary membership will be made at General Goethals' convenience—it is hoped at the Annual Meeting in December.

Report of Nominating Committee

The Secretary announces the receipt of the report from the Nominating Committee, charged with the duty of nominating candidates for offices in the ensuing year:

June 16, 1917

To the Secretary:

Dear Sir—The Nominating Committee, appointed by the President to submit names of nominees for the various elective offices next falling vacant under the Constitution, report that after considering the communications from the membership and as a result of several meetings of the committee and conferences with the Sections, the following gentlemen have been selected. The committee has communicated with each and has their acceptance in writing of the nominations.

For President for one year:
Charles T. Main, Boston, Mass.
For Vice-Presidents, for two years:
Spencer Miller, New York, N. Y.
Max Toltz, St. Paul, Minn.
John Hunter, St. Louis, Mo.
For Managers, for three years:
Fred A. Geier, Cincinnati, O.
D. R. Yarnell, Philadelphia, Pa.
Fred N. Bushnell, Boston, Mass.
For Treasurer:
William H. Wiley, New York, N. Y.

Respectfully submitted,
(*Signed*) L. E. Strothman,
Willis H. Carrier,
Frederick W. Gay,
A. M. Lockett,
Paul B. Morgan.

Engineering Council

In order to provide coöperation between engineering societies and for the consideration of questions of general interest to engineers and their relations to the public, and to provide a means for united action upon questions of common concern to engineers, the United Engineering Society has established the Engineering Council. It has been instituted with the A.S.C.E., A.I.M.E., A.S.M.E. and A.I.E.E., each having five representatives upon the Council and the United Engineering Society having four representatives. Provision has been made for increasing the number of Societies represented on the Council.

The Council may speak authoritatively for all member societies on public questions of a common interest or concern to engineers.

By-laws governing the activities of the Council have been drawn up and added as amendments to the by-laws of the United Engineering Society.

The representatives on the Council who have thus far been appointed, are as follows:

American Society of Civil Engineers:

Geo. F. Swain	John D. Galloway
Frederick H. Newell	John F. Stevens
Alexander C. Humphreys	

American Institute of Electrical Engineers:

H. W. Buck	P. Junkersfeld
E. W. Rice, Jr.	C. E. Skinner
N. A. Carle	

American Institute of Mining Engineers:

P. N. Moore	J. Parke Channing
S. J. Jennings	Edwin Ludlow
B. B. Lawrence	

The American Society of Mechanical Engineers:

I. N. Hollis	A. M. Greene, Jr.
Charles Whiting Baker	D. S. Jacobus
John H. Barr	

United Engineering Society:

Clemens Herschel	I. E. Moultrop
B. B. Thayer	Calvert Townley

ROLL OF HONOR

To the lists already published of those members of the Society who have enlisted in the national service is added the following supplement:

Baldwin, Bert L., Captain, Engineer Officers' Reserve Corps.*
Blood, John Balch, First Lieutenant, U. S. S. Nebraska.
Goetzenberger, Ralph L., First Lieutenant, Ordnance, Officers' Reserve Corps.
Hiles, Elmer K., Captain, Fifth Regiment, Engineer Officers' Reserve Corps.
Howell, Arthur K., Ordnance Dept., Officers' Reserve Corps.*
Hurxthal, Alpheus O., Lieutenant, Ordnance, Officers' Reserve Corps.*
Lynde, Charles C., Engineer Officers' Reserve Corps Camp at Ft. Oglethorpe, Ga.
Maynz, Theodore, Engineer of the Signal Corps, Aviation Department.*
Meixner, Bernard A., Captain, Quartermaster Corps or Ordnance Dept., Engineer Officers' Reserve Corps.*
Morton, Harold S., Reserve Officers' Training Camp at Fort Snelling, Minn.
Mount, Carroll H., First Lieutenant, Ordnance, Officers' Reserve Corps.*
Nickerson, Charles W., Assistant Naval Constructor in the Naval Coast Defense Reserve, U. S. N. R. F., with provisional rank of Lieutenant (J.G.).
Penney, Charles F., Special Service Engineer, Engineer Officers' Reserve Corps.*
Reed, E. Howard, Lieutenant Commander, Torpedo Station, Newport, R. I.
Ritter, Ralph B., First Lieutenant, Ordnance, Officers' Reserve Corps.*
Roberts, Theodore C., Major, Engineer Officers' Reserve Corps.*
Shaw, James W., Captain, Engineer Battalion Wis. N. G.
Streeter, Robert L., Captain, Ordnance, Officers' Reserve Corps.
Vaughan, Aubrey W., Captain Quartermaster U. S. R., Asst. to Depot Quartermaster, Boston, Mass.
Wagner, Frederick H., Major, Ordnance, Officers' Reserve Corps.
Walsh, Walter V., Engineer Officers' Reserve Corps.*
Walsh, William F., Captain, Engineer Section, Officers' Reserve Corps.
Zeiger, Nelson A., First Lieutenant, Ordnance, Officers' Reserve Corps.

* Acceptance of commission pending at date of latest list from War Department.

CANDIDATES FOR MEMBERSHIP

TO BE VOTED ON AFTER AUGUST 10, 1917

THE American Society of Mechanical Engineers is an organization for mutual service of over 8000 engineers and associates coöperating with engineers. The membership of the Society comprises Honorary Members, Members, Associates, Associate-Members and Juniors, all elected by ballot of the Council. Application for membership is made on a regular form furnished by the Secretary which provides for a statement of the standing and professional experience of the applicant and requires references from voting members personally acquainted with the applicant. The requirements for admission to the various grades will be furnished upon request.

Below is the list of candidates who have filed applications for membership since the date of the last issue of The Journal. These are classified according to the grades for which their ages qualify them, and not with regard to professional qualifications, i.e., the ages of those under the first heading place them under either Member, Associate or Associate-Member, those in the next class under Associate-Member or Junior, and those in the third under Junior grade only. Applications for change of grading are also posted.

The Membership Committee, and in turn the Council, urge the members to scrutinize this list with care and advise the Secretary promptly of any objections to the candidates posted. All correspondence in this regard is strictly confidential. Unless objection is made to any of the candidates by August 10, 1917, and providing satisfactory replies have been received from the required number of references, they will be balloted upon by the Council. Those elected will be notified about September 15, 1917.

NOTE. The Council desires to impress upon applicants for membership that under the present national conditions the procedure of election of members may be somewhat slower than under normal conditions. The first step in the consideration of an application is taken by the Membership Committee, and this committee is composed of busy men, with fewer opportunities to meet together in these strenuous times.

NEW APPLICATIONS

FOR CONSIDERATION AS MEMBER, ASSOCIATE OR ASSOCIATE-MEMBER

Alabama

DUGGER, NEAL, Chief Scale Inspector, Tenn. Coal, Iron & R. R. Co., Ensley

KEISER, FRANKLIN B., President, Keiser-Geismer Engineering Co., Birmingham

Arizona

WHITE, JOHN H., with Ray Consolidated Copper Co., Hayden

California

SWEENEY, MORGAN L., Superintendent, Western Pipe & Steel Co. of California., Los Angeles

Colorado

LEHMAN, JOHN L. G., Mechanical and Structural Designer, Great Western Sugar Co., Denver

Connecticut

BEEBE, ROBERT O., Director, Boardman Apprentice Shops, New Haven

BIXBY, EZRA M., Chief Draftsman, Equipment Engineer's Staff, Winchester Repeating Arms Co., New Haven

EISENWINTER, EDWARD E., Mechanical Engineer, American Brass Co., Waterbury

GRIFFITHS, WILLIAM H., Leading Designer, The Pratt & Whitney Co., Hartford

ZACHARIAS, ERNEST O., Investigating Engineer, Remington Arms & Ammunition Co., Bridgeport

District of Columbia

NELSON, JOHN H., Associate Engineer-Physicist, Bureau of Standards, Washington

Georgia

THAYER, WILLIAM B., Engineer and Draftsman, Goldens' Foundry & Machine Co., Columbus

Illinois

ADAMS, CLYDE L., Instructor in Machine Shop, Lewis Institute, Chicago

CARTER, WILLIAM C., Superintendent, Link-Belt Co., Chicago

EDWARDS, JOSEPH B., President and General Manager, Kellogg Switchboard & Supply Co., Chicago

HAYNES, HUGH W., Chief Draftsman, Scott St. Works, American Steel & Wire Co., Joliet

LUNDBERG, CHARLES, Western Editor, The Iron Age (Nobel School), Chicago

O'DONNELL, THOMAS E., Department Head, Western Electric Co., Inc., Chicago

REYNOLDS, GEORGE D., President and General Manager, Reynolds Pattern & Machine Co., Moline

SCANLON, THOMAS J., Engineer-Custodian, Board of Education, Chicago

SLINING, BYRON G., Construction Engineer, Illinois Traction System, Peoria

Indiana

CURRY, JOHN R., Secretary, Hall-Curry Construction Co., Indianapolis

MOHLER, CHARLES M., Superintendent, Empire Automobile Co., Indianapolis

RUBENKOENIG, HARRY, Instructor Car and Locomotive Design, Purdue University, Lafayette

SMITH, DOLPH I., Chief Engineer, Hill Pump Co., Anderson

WRIGHT, WILLIAM H., Superintendent, Citizens Gas Co., Indianapolis

Iowa

GIBSON, WILLIAM C., Works Manager, Morrison Brothers, Dubuque

Kansas

CHAPMAN, EDMUND E., Assistant Engineer Tests, Atchison, Topeka & Santa Fe Railway Co., Topeka

Massachusetts

FISHER, EDWARD J., Engineer in Charge of Gauge Division, New England Westinghouse Co., Chicopee Falls

FITCH, CHARLES R., General Manager, The Stanley Works, Bridgewater

HOTCHKISS, WALTER A., Mechanical Engineer, New England Drawn Steel Co., Mansfield

LEWTHWAITE, ALFRED L., Mechanical Engineer, High Voltage Bushing Engineering Department, General Electric Co., Pittsfield

MERRILL, CHARLES F., Assistant Chief Draftsman, Draper Corp., Hopedale

MOORE, CARL F., Consulting Engineer, United States Smelting, Refining & Mining Co., Boston

Michigan

ALBRIDGE, KENNETH P., Production Engineer, Parker Mfg. Co., Detroit

McMULLEN, GEORGE K., President and Manager, McMullen Machinery Co., Grand Rapids

MAPLE, OMAR S., Chief Engineer, Diamond Power Specialty Co., Detroit

Missouri

BOEHMER, EARNST J., Chief Engineer, Rice-Stix Dry Goods Co., St. Louis
BRADLEY, EUGENE P., Co-partner, Hester Bradley Co., St. Louis
SCHAUM, ARTHUR H., Chief Draftsman, Heine Safety Boiler Co., St. Louis

New Jersey

BERTHOLD, GEORGE H. E., Superintendent, Rajah Auto Supply Co., Bloomfield
FURMAN, GEORGE B., Chief Engineer, L. O. Koven & Brother, Jersey City
GULLIVER, ALBERT E., Chief Engineer, Trenton & Mercer County Traction Corp., Trenton
KIHM, OTTO R., Superintendent, American Can Co., Edgewater
LANG, JOHN F., Superintendent, Oxweld Acetylene Co., Newark
McMILLAN, DANIEL G., Power Plant Engineer, Singer Manufacturing Co., Elizabeth
PETERSON, JOHANN, Superintendent, Manhattan Electric Supply Co., Jersey City
SMITH, RALPH L., Engineer, Machine and Tool Designer, The Celluloid Co., Newark
TAYLOR, FRANK E., Master Mechanic, Butterworth-Judson Corporation, Newark Transfer

New York

BANKS, THOMAS K., Engineer, Steam Meter Department, American District Steam Co., North Tonawanda
BLOHM, AUGUST H., Mechanical Draftsman, The Adder Machine Co., New York
EMRICK, GEORGE W., Factory Manager, Eastern Flexible Conduit Co., Brooklyn
FOWLER, RICHARD E., Mechanical and Sales Engineer, Gerdes & Co., New York
GARDINER, HERBERT L., Shop Engineer, Kerr Turbine Co., Wellsville
HULL, GEORGE W., Engineer and Chief Draftsman, Halcomb Steel Co., Syracuse
JUDSON, CYRUS F., Engineer, A. J. Coccaro & Co., New York
LEGGO, WILLIAM F., Assistant to Chief Engineer, New York
McCARTHY, RALPH, Secretary, Corrugated Bar Co., Buffalo
McDONALD, ALBERT, Production Engineering, New York
MILLER, FRANKLIN T., President, F. W. Dodge Co., New York
MOYER, MELBOURNE S., Accountant, Barclay Parsons & Klapp, New York
NACKE, ARNOLD L., Salesman, Manning, Maxwell & Moore, New York
O'CONNELL, JOHN J., Assistant Hydraulic Engineer, Electric Bond & Share Co., New York
POWERS, RICHARD E., Factory Engineer, Oneida Community, Ltd., Oneida
RILEY, CHAMPLAIN L., Consulting Engineer in Heating, Ventilation and Industrial Plant Design and Equipment, New York
SMITH, GERSHOM, Vice-President, The Tabulating Machine Co., New York
SNEDEKER, THEODORE A., Assistant Treasurer, The Taft-Peirce Mfg. Co., New York
WOLLHEIM, WALTER E., Assistant Mechanical Engineer, Nathan Manufacturing Co., New York

Ohio

ATKINSON, EMBRY S., Head of Tool Design, Domestic Engineering Co., Dayton
CARLISLE, TYLER W., Assistant Secretary and Treasurer, The Strong Carlisle & Hammond Co., Cleveland
JAMISON, WALTER K., Superintendent, Domestic Engineering Co., Dayton
KAISER, LOUIS T., Mechanical Engineer, Thomas Emery's Sons, Cincinnati
MEHLE, J. H., Manager, Cincinnati Screw Co., Cincinnati
MURPHY, JAMES A., Foundry Superintendent, The Hooven, Owens, Rentschler Co., Hamilton
SCHELLENBACH, WILLIAM S., Mechanical Engineer, Cincinnati
WARDWELL, FRANK W., JR., President and General Manager, The Wardwell Mfg. Co., Cleveland

Oregon

SULLIVAN, ALLAN C., Chief Engineer in charge of Estimating Dept., Smith & Watson Iron Works, Cortland

Pennsylvania

AMMERMAN, C. S., Ordnance Designer, Bethlehem Steel Co., Ordnance Dept., Bethlehem
BAUER, GEORGE A., Vice-President, W. E. Sniplev Machinery Co., Philadelphia
BENEDICT, JOHN G., Secretary, Treasurer and Manager, Landis Machine Co., Waynesboro
CONE, MARTIN B., Chief Engineer, Baugh & Sons Co., Philadelphia
COOPER, DAVID M., Mechanical Engineer, National Metal Molding Co., Ambridge
DUNCAN, HAROLD M., Managing Director, Lanston Monotype Corp., Ltd., of London, England, Philadelphia
FLEISHER, WALTER A., Head of Power Department, S. B. & B. W. Fleisher, Inc., Philadelphia
FROELICH, CLARENCE H., Ordnance Engineer, Bethlehem Steel Co., So. Bethlehem
JACKSON, ELWELL R., Mechanical Engineer, Edward Board, Special Machinery and Tools, Philadelphia
SIMPSON, WILLIAM L., General Superintendent, Eddystone Ammunition Corp., Eddystone
SNYDER, BARNEY B., Representative and Inspector, Chile Exploration Co., Pittsburgh
TAYLOR, ROGER, Engineer, Operating Department, Philadelphia Electric Co., Philadelphia
THOMSON, CLARKE, Manager, Clarke Thomson Research, Philadelphia
WALLER, C. B. F., Engineer in Charge of Boilers, Bureau of Water, Philadelphia
ZEHR, VRATISLAV A., Mechanical Draftsman, Switchboard Engineering Dept., Westinghouse Electric & Manufacturing Co., East Pittsburgh

Rhode Island

PEARSON, MARK, Mechanical Engineer, Bradford Dyeing Association, Bradford

Texas

HUGHES, HOWARD R., President, Hughes Tool Co., Houston

Virginia

SCHMIDT, OTTO DA COSTA, Chief Engineer, Covington Machine Co., Covington

West Virginia

WINDSOR, WALTER A., President, Marietta Manufacturing Co., Point Pleasant

Wisconsin

HEM, EILIF S., Erecting Engineer, Allis-Chalmers Mfg. Co., Milwaukee
MILLER, ROY J., Works Manager, Kohler Co., Kohler

Canada

GAINES, EDWARD C., Designing Engineer, Dominion Bridge Co., Montreal
McNAUGHT, FRANK H., Manager, Maritime Foundry & Machine Works, Ltd., Chatham, N. B.
ROBERTS, ARTHUR R., Associate Professor of Mechanical Engineering, McGill University, Montreal

Chile

VILLEGAS, JORGE ANDRES D., Manager Engineering Office, Private Practice, Santiago

Hawaii

EWART, ARTHUR F., Chief Draftsman, Honolulu Iron Works Co., Honolulu

India

IYENGAR, R. RAMAUJA, Manager, Sandalwood Oil Factory, Bangalore

FOR CONSIDERATION AS ASSOCIATE-MEMBER OR JUNIOR

Alabama

PRATT, MERRILL E., With Continental Gin Co., Prattville

California

HARTZELL, EARL F., Draftsman and Engineer, Southern Pacific Co., Bakersfield
TOUR, REUBEN S., Assistant Professor Gas Engineering, University of California, Berkeley

Cuba

STUART, JOSEPH L., Mechanical Engineer, Honolulu Iron Works Co., Havana

Illinois

HOSBEIN, LOUIS, Secretary and Manager, M. H. Detrick Co., Chicago

LOWRY, Thomas K., Manager,
Armour & Co. (Manufacturing Plant), Chicago
NELSON, Arthur W., Consulting Engineer,
Lund & Nelson, Chicago
PETTIS, John G., Mechanical Engineer, Specializing,
Imperial Brass Mfg. Co., Chicago
SHANKLIN, Andrew D., Assistant Superintendent,
Fayville Plant, Aetna Explosives Co., Inc., Fayville

Indiana
LIBBY, William L., Vice-President and Sales Manager,
International Machine Tool Co., Indianapolis

Massachusetts
POHLE, Walter B., Machine and Tool Designer and Draftsman,
General Electric Co., Lynn
SHEPARD, Frederick J., Jr., Treasurer and Chief Engineer,
Lewis-Shepard Co., So. Boston

Michigan
BAKER, Hubert E., Assistant Chief Draftsman,
The Shaw Electric Crane Co., Muskegon
HINZ, Julius C.,
703-19 Bellevue Avenue, Detroit
HOUCK, Frank H., Mechanical Engineer,
Higrade Motors Co., Grand Rapids
WATSON, William W., Manager Order Department,
Anderson Forge & Machine Co., Detroit
WOLCOTT, Ward S., Assistant to Chief Tool Designer,
Burroughs Adding Machine Co., Detroit

Minnesota
MIKESH, Martin A., Designer,
Fairmont Gas Engine & Rwy. Motor Car Co., Fairmont
THOMPSON, Jesse L., Assistant to Superintendent of Power,
Minnesota and Ontario Power Co., International Falls

Missouri
ARMSTRONG, William H., Instructor Machine Shop Practice,
The David Ranker Jr. School of Mechanical Trades, St. Louis

New Jersey
BUESSER, Fred F., Jr., Estimating Engineer,
L. O. Koven & Bro., Jersey City
GERHARDT, Joseph A., Estimating Engineer,
L. O. Koven & Bro., Jersey City

New York
BROWNE, Robert L., Commercial Engineer,
Goldschmidt Thermit Co., New York
FEELEY, John J., Assistant Chief Engineer and Master Mechanic,
Tuttle & Bailey Manufacturing Co., Brooklyn
GRAMM, Edgar B., Assistant Chief Draftsman,
Combustion Engineering Corporation, New York
HORN, Charles J., Chief Draftsman,
Otis Elevator Co., Yonkers
LAWSON, William S., Jr., President and Treasurer,
Lawson & Co., Inc., New York
MOSS, Herbert H., Assistant Engineer,
Aetna Explosives Co., Inc., New York
ROMAN, Henry, Draftsman, Experimental Department,
Sperry Gyroscope Co., Brooklyn

Ohio
MATTLE, Gustave A., Pattern Shop Foreman,
Modern Foundry Co., Cincinnati
NEWCOMB, Melvin B., Draftsman,
Firestone Tire & Rubber Co., Akron
ROBINSON, Kinsey, with the American Can Co., Hamilton
TABER, Merl N., Metallurgist,
The National Supply Co., Toledo
WILLIAMSON, Richard A., Foreman in Charge Mch. Operations,
Aultman & Taylor Machinery Co., Mansfield

Pennsylvania
CORRIDON, Edwin R., Designing Draftsman,
Ordnance Department, Bethlehem Steel Co., So. Bethlehem
HESS, Ernest E., Draftsman and Designer,
Spang & Co., Butler
HODDICK, Frederick G., Ordnance Engineer,
Bethlehem Steel Co., So. Bethlehem

Tennessee
WILLARD, John A., Mechanical Engineer,
Bemis Bros. Bag Co., Bemis

Wisconsin
CROSSEN, Elmer J., Coke Oven Engineer,
The Milwaukee Coke & Gas Co., Milwaukee
WEHR, C. Frederic, Superintendent,
Wehr Steel Co., West Allis

FOR CONSIDERATION AS JUNIOR

California
HAMAKER, Rex G., with Standard Oil Co., Whittier
LACY, Richard W., formerly with Lacy Manufacturing Co.,
Los Angeles
WEBSTER, Frederick A., Jr., Foreman, Inspection Department,
Standard Oil Co., Richmond

District of Columbia
LEWIS, Allen D., Draftsman,
Office of Chief of Ordnance, War Department, Washington

Illinois
CATTERMOLE, Lester G., Chief Planning Engineer,
Federal-Huber Mfg. Co., Chicago
PAINTER, Walter, Lubrication Engineer,
Sinclair Refining Co., Chicago
STEVENS, Berry T., Assistant Sales Manager,
Hard Rubber Department, The B. F. Goodrich Co., Akron
THAL, Samuel W., Engineering Department,
American Steel & Wire Co., Waukegan

Iowa
WATKINS, Roy A., Superintendent,
American Machine Products Co., Marshalltown

Kentucky
RITCHIE, Andrew O., Designing Power Plants,
J. D. Lyon, Engineer, Cincinnati

Maryland
MATHER, Harold T., Safety Engineer,
Aetna Life Insurance Co., Baltimore

Massachusetts
BROWN, Arthur L., Instructor,
Massachusetts Institute of Technology, Boston
GOODMAN, Harry M.,
With Fore River Shipbuilding Corp., Quincy
HEYWOOD, Charles E., Student,
Worcester Polytechnic Institute, Worcester
LUNN, John A., Assistant,
Massachusetts Institute of Technology, Boston
MUNSON, Kenneth A., Tool Designer,
General Electric Co., West Lynn

Mexico
de AROZARENA, Rafael M., Jr., Resident Engineer,
Hacienda de San Juan Hueyajan, Padruca

Michigan
EDWARDS, Herbert C., Experimental Research,
Packard Motor Car Co., Detroit
REKERSDRES, Henry, Production Clerk,
American Blower Co., Detroit
SCHUPP, Arthur A., Student,
University of Michigan, Ann Arbor

Minnesota
ABERNETHY, Wilbur K., Sales Engineer,
Charge Minneapolis Office, Central Station Steam Co., of Detroit,
Minneapolis

New Jersey
BLOOD, Harold L., Chief Draftsman, Planer Dept., Pond Works,
Niles-Bement-Pond Co., Plainfield
McMURRAY, John H., Assistant Mechanical Engineer,
Calco Chemical Co., Bound Brook
WATERS, Daniel V., Machine Designer, Engineering Dept.,
S. L. Moore & Sons Corp., Elizabeth

New York
BERKOWITZ, Benjamin, Laboratorian,
U. S. Navy Department, Navy Yard, Brooklyn
FELL, Shelby G.,
With H. H. Franklin Mfg. Co., Syracuse
FERNSTROM, Frodee S., Mechanical Draftsman,
Neptune Meter Co., Long Island City
FINCH, Cecil C., Superintendent,
Broadalbin Knitting Co., Ltd., Broadalbin
GILBERT, Frederick B., Experimental Engineer,
Research Laboratory, Ansco Co., Binghamton
HENRY, William M.,
Officers Training Camp, Plattsburg
JOHN, George H., Jr., Student, Mechanical Engineering,
Columbia University, New York
LANGLOTZ, Charles L., Assistant Engineer,
American Sugar Refining Co., Brooklyn
LOO, Ping-Yok, Representative to China,
Allied Machinery Co. of America, New York
MAIN, Charles C., Jr., Assistant Eastern Manager,
Curtis & Co. Mfg. Co., New York

MATTHIAS, MAXIMILIAN P., Assistant to Dr. J. C. Olsen, Cooper Union, New York
POSTMAN, BENJAMIN, Testing Bureau, Brooklyn Rapid Transit Co., Brooklyn
SLADE, HENRY L., JR., Manufacturing Machinery, R. Hoe & Co., New York

Ohio

FIKRET, H. HALOUK, Instructor in Mechanical Engineering, Robinson Laboratory, Ohio State University, Columbus
FLAGG, PAUL M., Experimental Department, Goodyear Tire & Rubber Co., Akron
STINSON, KARL W., Instructor Aero Engines, Cadet Aviation School, Ohio State University, Columbus
WILLIAMS, BERKELEY, Graduate Fellow, Department of Mechanical Engineering, University of Cincinnati, Cincinnati

Pennsylvania

CROUTHAMEL, JOHN F., Draftsman, Artillery Dept., Midvale Steel & Ordnance Co., Philadelphia
CUTLER, JAMES B., With I. P. Morris Co., Philadelphia
HANSEN, FREDERICK D., Superintendent Cartridge Case Shop, Eddystone Ammunition Corp., Eddystone
RESNICK, MAURICE, General Engineering Apprentice, Shelby Steel Tube Co., Ellwood City

Texas

BEEN, PAUL, 2nd Engineers, Company C, El Paso
EVANS, MELVIN J., Special Apprentice, Gulf, Colorado & Santa Fe R. R. Co., Cleburne
FORNEY, ROSS H., Chief Dispatcher, Texas Power & Light Co., Dallas

West Virginia

CATHER, CARL H., Instructor in Drawing, West Virginia University, Morgantown

Wisconsin

WOOD, JOHN M., Draftsman, Equipment Department, The Falk Co., Milwaukee

Wyoming

KEELEY, WILLIAM C., JR., Engineer, Mid-West Refining Co., Casper

Cuba

ADAM, LEON E. M., Chief Chemist, Cuba Cane Sugar Corp., Central Moron, Pina

APPLICATIONS FOR CHANGE OF GRADING

PROMOTION FROM ASSOCIATE

Cuba

SOPER, ELLIS C., Chief Engineer, Cuban Portland Cement Co., Cayo Mason

PROMOTION FROM ASSOCIATE-MEMBER

Massachusetts

PERKINS, GEORGE H., Head of Textile Engineering Department, Lowell Textile School, Lowell

Canada

SOUBA, WILLIAM H., Consulting Engineer, C. D. Howe & Co., Port Arthur

Chile

DU MOULIN, WALTER L., Mechanical Engineer, Andes Copper Mining Co., Chanaral

PROMOTION FROM JUNIOR

Connecticut

WILCOX, HERBERT M., Industrial Engineer, Winchester Repeating Arms Co., New Haven

Louisiana

IVENS, EDMUND M., Sales Engineer, Skinner Engine Co., and Ingersoll-Rand Co., New Orleans

Massachusetts

EDWARDS, WILLIAM W., Instructor in charge of Department, Wentworth Institute, Boston
NICHOLL, JOHN S., President, Riverside Boiler Works, Inc., Cambridge

Michigan

FESSENDEN, CHARLES H., Assistant Professor of Mechanical Engineering, University of Michigan, Ann Arbor
ORDWAY, EARL P., Chief Draftsman, Union Steam Pump Co., Battle Creek

New York

BERANGER, JOSEPH P., Chief Engineer, West India Management & Consultation Co., Inc., New York
COLLINS, FRANCIS A., JR., Sales Manager, Auburn Ball Bearing Co., Rochester

Ohio

CANBY, HARRY B., Vice-President, Crawford, McGregor & Canby Co., Dayton
CLAPP, RICHARD B., District Manager, Andrews-Bradshaw Co., Cleveland

Pennsylvania

BRENNAN, JAMES, Consulting Engineer, Pittsburgh

Rhode Island

KEABLES, AUSTIN D., Mechanical Engineer, Slatersville Finishing Co., Slatersville

Tennessee

FEICHT, EDWARD R., Maintenance Engineer, Federal Dyestuff & Chemical Corp., Kingsport

Wisconsin

SHODRON, JOHN G., General Superintendent, James Mfg. Co., Fort Atkinson

SUMMARY

New applications	200
Applications for change of grading:	
Promotion from Associate	1
Promotion from Associate-Member	3
Promotion from Junior	14
Total	218

SUMMARY SHOWING AVERAGE AGE AND POSITIONS OF APPLICANTS ON BALLOT CLOSING MAY 19, 1917

Boiler Inspector	1
Cadet Engineer	1
Chief Engineers	15
Chief Engineers, Assistant	4
Combustion Engineers	2
Combustion Engineers, Assistant	1
Construction Engineers	4
Consulting Engineers	7
Designers	5
Director Technical Research	1
Draftsmen	12
Draftsmen (designing)	3
Chief Draftsmen	12
Chief Draftsmen, Assistant	1
Efficiency Engineers	6
Equipment Engineer	1
Equipment Engineer, Assistant	1
Executives (President, Vice-President, Treasurer, Secretary, Managers and District Managers)	42
Fuel Engineer	1
Industrial Engineers	2
Inspectors	5
Instructors	8
Maintenance Engineer	1
Marine Engineers	2
Master Mechanics	2
Mechanical Engineers	49
Mechanical Engineers, Assistant	12
Operating Engineers	3
Patent Attorney	1
Plant Engineer	1
Production Engineers	3
Professor	1
Professor, Assistant	2
Purchasing Agent	1
Representative	1
Research Engineer	1
Sales Manager	3
Sales Manager, Assistant	1
Sales Engineer	13
Service Manager	1
Students	2
Superintendents	27
Superintendents, Assistant	11
Superintendents, Power	1
Works Manager	3
Miscellaneous	29

NECROLOGY

CHARLES EDWARD HYDE

Charles E. Hyde was born in Bath, Me., November 26, 1855. He attended the public schools of Bath, and, when graduated from the high school there, spent the next three years in the Worcester Polytechnic Institute. The last year of his course was taken in the Massachusetts Institute of Technology. The year after his graduation he spent in Europe for the purpose of examining the shipyards and engine works of the old country, obtaining valuable information in his specialty.

Upon his return he worked as machinist in the Portland Machine Shops, and then as draftsman in the Columbian Iron Works at Baltimore, Md. He was next employed in the drawing office of Cramp's Shipyard, Philadelphia, Pa., and later was chief draftsman for Ward, Stanton & Company, Newburg, N. Y., builders of all types of fast vessels. This last position afforded him the advantage of working with Mr. Stanton, who was noted for his ability as a designer of marine engines.

Returning to Bath in 1884, he entered the employ of the Goss Marine Iron Works as chief draftsman and superintendent, and during his service there he introduced the practical use of the triple-expansion engine, the first to be employed in this country. When this company changed ownership, he was employed by the Bath Iron Works, and was chief draftsman and constructor of the engines of the *Castine, Katahdin* and *Machias.*

After leaving Bath he became general manager and president of the New London Marine Iron Works, at New London, Conn. For the last few years he was engaged in business in New York City.

He was a member of the Society of Naval Architects and Marine Engineers and of the Engineers' Club of New York. He became a member of the Society in 1885. He died May 19, 1917.

ROSCOE B. KENDIG

Roscoe B. Kendig was born in Renova, Pa., March 3, 1868. He received his education in the home schools. He began railway work in 1884 as a messenger boy in the employ of the Pennsylvania Railroad. From 1885 to 1890 he served as machine apprentice, and until 1893 as draftsman in Renova. For the next seven years he held the position of draftsman in the office of the superintendent of motive power of the Pennsylvania road, at Williamsport, Pa. In 1900 he was appointed chief draftsman of the Lake Shore & Michigan Southern Railway at Cleveland, O., and in 1904 he accepted the position of mechanical engineer with the same road.

He held this position until 1910, when he was appointed general mechanical engineer of the New York Central lines; and in 1912 he became chief mechanical engineer of the New York Central Railroad Company, which position he held at the time of his death.

He was a significant factor in the development, design and construction of the Collingwood shops of the New York Central Railroad. While he was mechanical engineer of the Lake Shore & Michigan Southern road, the modernization of the locomotive terminal facilities was undertaken under his immediate supervision, and large modern engine houses were erected, many of the features of which have served as a model for later construction of this nature.

He was since 1904 an active member of the American Railway Master Mechanics' Association, and since 1905 of the Master Car Builders' Association. He was a member also of the American Society for Testing Materials and of the Engineers' Club of New York.

He became a member of the Society in 1913. He died May 10, 1917, at Detroit, Mich.

OSCAR PATRIC OSTERGREN

Oscar Patric Ostergren was born in Sweden, May, 1866. He was educated in Stockhorm, graduating from the Royal Technical High School with the degree of M.E. in 1888. From 1888 to 1891 he was employed by Treacher, Tenac & Co., civil engineers and contractors, in drafting and surveying a new railroad at Rosario, Argentina. The next year he spent with the Atlas Machine Company, Stockholm, as assistant engineer. He came to New York late in 1892, and was employed in erecting machinery by Robert Hoe & Co. From 1893 to 1896 he worked with Charles D. Mosher, a naval architect of New York, in designing marine engines, and until 1898 he was with Charles L. Seabury & Co., New York City, in the same work. He then became president and general manager of the Ostergren Manufacturing Company, having complete charge of the inventing and designing of liquid-air machinery, internal-combustion engines, and automobiles. From 1902 to 1904 he was with the Fuel Oil Power Company as an inventor and designer of fuel-oil engines. Later he successively held positions with Benjamin Hurd, New York City; Joseph Boyer, Detroit, Mich.; Alger Bros., Detroit, Mich.; and with the Grenetso Engineering Company. He held fifty United States patents on inventions.

He joined the Society in 1910. He died May 11, 1917.

JOHN MITCHELL YOUNG

John Mitchell Young was born in Ardrossan, Ayrshire, Scotland, Sept. 18, 1883. He received his early education in the Glasgow High School for Boys. He then entered the Glasgow and West of Scotland Technical College as a day student, graduating in 1904 from the mechanical-engineering course. He was elected an associate of the college. During his last year in college he carried on investigations having to do with steam turbines, and for a thesis embodying these investigations he received the Montgomerie-Neilson gold medal and prize.

He then entered upon an apprenticeship in the works of William Young & Sons, engineers and ironfounders in Ardrossan. On the completion of his apprenticeship he became a draftsman of sugar machinery with Mirlees Watson & Co., Glasgow. In 1909 he came to the United States, where he took a position as draftsman in the steam-turbine department of the Fore River Shipbuilding Company, Quincy, Mass. He next turned his attention to electrical engineering, and took a position with the General Electric Company, Schenectady, N. Y., as draftsman. Later he took charge of the construction office for the power plant of the Toronto Power Company, Niagara Falls, Ont. He next took up the study of sugar machinery, and became a designer with the Dyer Company, Cleveland, Ohio, and later with the Geo. L. Squier Company, Buffalo, N. Y. For the former company he designed and equipped a complete sugar factory in Louisiana. He became interested in conveying and elevating machinery, and for the next two years he occupied the position of factory equipment engineer and designer with the Otis Elevator Company, Buffalo, N. Y.

He was an associate member of the Institute of Engineers and Shipbuilders in Scotland. He became an associate-member of the Society in 1915. He died March 14, 1917.

AMONG THE SECTIONS

Sections Delegates Meet at Cincinnati

THE Committee on Sections arranged a business meeting at the Spring Meeting at Cincinnati which was preceded by a luncheon attended by the following: President Ira N. Hollis, Past-Presidents Oberlin Smith, W. F. M. Goss and James Hartness; Messrs. John H. Barr and Max Toltz, Managers of the Society; Calvin W. Rice, Secretary; D. Robert Yarnall, chairman, L. C. Marburg and Walter Rautenstrauch, members of the Committee on Sections; also the following representatives of Sections: Atlanta, Earl F. Scott; Baltimore, C. C. Thomas and A. G. Christie; Birmingham, W. P. Caine and J. G. Hatman; Buffalo, C. H. Bierbaum; Cincinnati, Fred A. Geier and John T. Faig; Detroit, George W. Bissell; Erie, Rudolph Conrader and M. W. Sherwood; Indianapolis, W. H. Insley; Milwaukee, Fred H. Dorner; Minnesota, Max Toltz; New Orleans, A. M. Lockett; New York, Ernest Hartford; Philadelphia, D. Robert Yarnall; Ontario, Chester B. Hamilton, Jr.; Worcester, R. G. Williams; and Providence, L. D. Burlingame and A. H. Annan.

Dr. Hollis spoke forcibly concerning the broad principles underlying the Society and its duty to the profession, and particularly of the ideals entertained by the Council for furthering the sections work. Following this speaker, the chairman called for reports from the delegates representing the various sections, and each gave the experiences of his section in turn.

One excellent point brought out and very generally endorsed was that each section of the Society should send to every other section notices of all its meetings, so that each section could be continually posted on just what is going on in the other sections. It was thought that this matter could best be handled by having each section secretary send to the headquarters of the Society twenty-five copies of each meeting notice and having the secretary of the Sections Committee readdress these to the other sections.

A question was raised concerning the amount of money that the Society should appropriate to the sections and it was decided to make recommendations to the Council.

Mr. Rice spoke on the matter of publication of sections material in THE JOURNAL and in Transactions. He complimented the sections on the value of this material received in the past, which had led the Publication Committee to inaugurate a new policy—to devote several issues of THE JOURNAL each year to sections papers. He hoped that each section would contribute its full share toward the best realization of that policy by contributing at least two papers each year for publication. The Sections Committee promised to help the sections toward the realization of this ideal.

D. ROBERT YARNALL,
Chairman Sections Committee.

Sections Meetings

BIRMINGHAM

May 16 A feature of the annual meeting was a two-reel moving picture illustrating the old and new methods of cooking,—coal versus electricity, after which the chairman gave a review of the progress the past year.

During the year the hearty coöperation and support of the two state universities has been enlisted and two representatives from each have addressed the Section. Ten or twelve new members have been secured for the Society through the efforts of the Section, which has also been influential in the organization of the Alabama Technical Association, which includes all the members of the national engineering societies residing in the State of Alabama, of whom there are over two hundred. A combination stereopticon and baloptican machine has been purchased for the use of the members, and it is hoped that greater use will be made of it the coming year.

The officers for the coming year were elected as follows: Chairman, J. H. Klinck; vice-chairman, W. P. Caine; secretary, J. G. Hatman. Paul Wright and R. E. Brakeman were also elected members of the executive committee.

R. E. BRAKEMAN,
Section Chairman.

BUFFALO

June 7 Chester L. Lucas, Mem.Am.Soc.M.E., explained to a large and interested audience the manufacture of 9.2-in. high explosive howitzer shells, illustrating his talk with 2500 ft. of moving-picture film.

Mr. Lucas gave the following interesting data concerning these shells: the weight of each is 250 lb. with an explosive element capable of blowing a hole 50 ft. in diameter in the ground; the cost of the shell was two hundred dollars, while the forging alone costs twenty-five dollars and machining about twenty-eight dollars. It takes about ten man-hours to make one shell.

LOUIS J. FOLEY,
Assistant to Secretary.

CHICAGO

May 18 The first social meeting in the history of the Section to which ladies were invited, proved such a success that it was unanimously decided to hold others in the future.

S. J. Duncan-Clark, war analyst of the Chicago *Evening Post*, gave an intensely interesting address on The War Situation of Today. In order to give the audience the proper perspective the speaker reviewed the incidents leading up to the war, starting with the Kaiser's trip to Palestine in 1898 and the concession given by the Turkish Government at that time to build the Bagdad Railway, which was the first step in the program of the empire that the Kaiser had conceived. Then followed the various intrigues to secure right of way to Saloniki and Constantinople, and the final spark at Belgrade that started the great conflagration. Leading his hearers step by step, the speaker ably reviewed the situation on each front with the final optimistic prediction of victory for the allied democracies over the last great autocracy.

A vote of thanks was tendered Mr. Duncan-Clark and a collection taken for the Red Cross.

The following officers were elected for the coming year: Chairman, Alexander D. Bailey; vice-chairman, H. T. Bentley; secretary, Arthur L. Rice. G. R. Brandon and P. N. Engel were elected members of the executive committee.

THOMAS WILSON,
Section Corresponding Secretary.

MINNESOTA

May 10 K. C. Richards, superintendent of the Minnesota By-Products Coke Company, gave an exceedingly interesting illustrated lecture on coke and its by-products, which was followed by several discussions.

By unanimous vote the following officers were elected for the coming year: Chairman, H. LeRoy Brink; vice-chairman, J. A. Teach; secretary and treasurer, Edward A. Wilhelm.

D. M. FORFAR,
Section Secretary.

NEW ORLEANS

April 2 A general business meeting at which the principal event was the election of officers, resulted in the following elec-

tions for the coming year: Chairman, H. L. Hutson; secretary, E. W. Carr; W. B. Gregory, A. M. Lockett, and R. T. Burwell, members of the board of direction.

H. L. Hutson,
Section Secretary.

WORCESTER

June 5 After a brief business meeting the delegates to the Spring Meeting gave their reports. Ira N. Hollis, President Am. Soc. M. E., followed with an address.

Dr. Hollis confined his remarks to the war situation, telling of the impressions he had gained while talking with high army and navy officials who accompanied the British and French Commissions to this country. He laid particular emphasis on the fact that this war is a huge business proposition, where the skill of the engineer in handling men and materials is perhaps the most important factor. His remarks touching on the submarine question were particularly interesting and instructive.

The following were elected officers for the coming year: Chairman, George I. Rockwood; secretary, Richard G. Williams. H. P. Fairfield, V. E. Edwards and F. W. Parks were elected members of the executive committee.

Richard G. Williams,
Section Secretary.

Student Branches

CARNEGIE INSTITUTE OF TECHNOLOGY

May 26 The Training of the Engineer was the subject of an interesting talk by J. H. McAlpine, of the Westinghouse Machine Company. The speaker outlined the training required, from the time of entrance to school until the chosen field had been reached.

The following officers were elected for the coming year: President, E. F. Obert; vice-president, E. P. Bateham; secretary, R. C. Brandin; treasurer, E. F. Morgan.

J. H. Davis,
Branch Secretary.

UNIVERSITY OF CINCINNATI

May 22 Several members of the Am.Soc.M.E. were present at the final meeting of the season and addresses were made by Ira N. Hollis, President, Am.Soc.M.E.; Calvin W. Rice, Secretary Am.Soc.M.E.; William Kent, Mem.Am.Soc.M.E., and Carl G. Barth, Mem.Am.Soc.M.E.

The election of officers was also held at this meeting, with the following results: President, Henry A. Wolsdorf; vice-president, E. H. Schubert; secretary and treasurer, Christ L. Koehler; publicity manager, Oliver F. Gang.

Henry A. Wolsdorf,
Branch Secretary.

UNIVERSITY OF ILLINOIS

May 10 In connection with the Pi Tau Sigma contest, C. Spindler spoke on the Eight-Cylinder Gasoline Engine. Mr. Spindler pointed out the advantages of this type of engine over the four-, six- and twelve-cylinder engines in use for automobiles. The talk was well illustrated with blackboard and chart demonstrations.

May 25 The conclusion of the Pi Tau Sigma contest was reached with the talks delivered at this meeting by J. T. Kelly, on the Heat Treatment of Steel, and by C. Z. Rosecranse, on The Railway Dynamometer Car.

The officers for the coming semester were also elected, as follows: President, H. C. Dieserud; vice president, J. T. Kelly; secretary, L. I. Phillis.

H. C. Dieserud,
Branch Secretary.

LEHIGH UNIVERSITY

May 10 The annual election of officers was the main feature of this meeting, which was purely one of business. The results were as follows: President, J. P. Clymer; secretary, W. A. Bornemann; treasurer, N. Dymtrow.

W. A. Bornemann,
Branch Secretary.

OHIO STATE UNIVERSITY

May 29 This meeting took the form of a banquet, and speeches were made by several faculty members and students. Later, William T. Magruder, Mem.Am.Soc.M.E., spoke on Aviation and illustrated his talk with a large number of lantern slides, which were of much interest to those present.

The officers for the coming year are as follows: President, Paul Bucher; secretary, Fillmore D. Swan; treasurer, E. A. Edwards.

F. E. Smyser,
Branch Secretary.

PENNSYLVANIA STATE COLLEGE

The officers for the coming year have been elected as follows: President, Robert S. Clark, Jr.; vice-president, L. C. Grove; treasurer, Robert K. Cochrane; secretary, P. G. Musser.

STEVENS INSTITUTE OF TECHNOLOGY

May 11. The following officers have been elected for the ensuing year: President, Herbert Peter; vice-president, Raymond S. Mileham; secretary and treasurer, G. Crosby Hiss.

G. Crosby Hiss,
Branch Secretary.

EMPLOYMENT BULLETIN

THE SECRETARY considers it a special obligation and pleasant duty to make the office of the Society the medium for assisting members to secure positions, by putting them in touch with special opportunities for which their training and experience qualify them, and for helping anyone desiring engineering services. The Society acts only as a clearing house in these matters.

POSITIONS AVAILABLE

In forwarding applications, stamps should be enclosed for transmittal to advertisers; applications from non-members should be accompanied by a letter of reference or introduction from a member, such reference letter to be filed with the Society. Copy for notices must be in hand by the 15th of the month.

DESIGNER on heavy machine tools and similar machinery. Good opportunity for high-grade designer chiefly with drawing-office experience. Salary, $2,400. Location, Pennsylvania. 40.

TOOL DESIGNER who is resourceful and can follow work through to completion. Technical man with practical shop experience. Salary, $25 to $35 per week, according to ability. Location, Connecticut. 185.

SALES ENGINEERS. It is desirable that applicants be young men between 25 and 30 years of age, preferably M. E. graduates of some approved engineering college, and of good appearance; would be expected to undergo a period of probation and training in various offices of company for responsible and higher positions in sales work. If a call cannot be made, application may be made by letter in applicant's own hand writing, stating age, education, previous business training, if any, salary desired, etc. Location, New York. 205.

SALESMEN for power-plant equipment—boilers, engines, forced-draft blowers, pumps and elevators. Commission basis. Location, New York City. 402.

TEACHER for large public institution of the Middle Northwest; strictly high-class man who can conduct classes and give lectures

upon automobiles. Must be technical graduate, with practical experience and not afraid of work. Location, Wisconsin. 421.

INDUSTRIAL ENGINEER—COST ACCOUNTANT. Well-established firm can offer exceptional opportunities for effective and interesting work to engineering graduates who have had substantial experience with modern industrial accounting; special reference to manufacturing costs. In reply state age, education, experience, present and expected salary. Location, Massachusetts. 431.

DRAFTSMAN, capable of designing machines of comparatively large size for boring and milling purposes; also fixtures and tools for use on such machines, to hold and perform work as shown by blueprints. Location, Providence. 525.

EXPERIENCED MAN to take charge of manufacture of soap powder. Salary $30 to start. Location, New York. 563.

DRAFTSMEN for stoker department of concern manufacturing a specialty. Work involves layouts of stoker installations and requires general knowledge of boiler-room work. Salary depending upon man's ability and experience, $25 per week to start. Good draftsman with a little knowledge of this class of work more valuable than good designer. Location, Philadelphia. 565.

PUMP DESIGNER experienced in design and construction of turbine pumps particularly, for large pump manufacturers. Location, South. 581.

DRAFTSMEN AND DESIGNERS familiar with power-plant and factory layouts. Location, Boston. 629.

COMBUSTION ENGINEER experienced in hand and stoker firing of bituminous coal, to study boiler efficiency and other combustion problems. Location, Delaware. 725.

PIPE AND POWER-PLANT MEN wanted by large rubber concern in Ohio. 727.

ENGINEER skilled in handling of materials, to study such work at plants of large industrial corporation; experience with conveying machinery and other mechanical means of transport of materials. Location, Delaware. 782.

TECHNICAL GRADUATE in mechanical engineering, with one or two years' experience in power-house installation and design; should understand piping layout and boiler setting, and be capable of inspecting such work during installation. Location, New Jersey. 865.

DRAFTSMAN who would be interested in investing some money in shop; one familiar with horizontal return tubular boilers and boiler-shop work in general. State age, experience and salary desired. Location, New Jersey. 881.

MACHINERY DESIGNER in turbine department of large electric company. Location, Massachusetts. 894.

MASTER MECHANIC for lead-smelting plant operating blast furnaces and concentrating mills; must be man of strong personality, capable of handling varied classes of mechanics. Give full details of education and experience. Location, Utah. 906.

DRAFTSMAN experienced in factory design and installation of elevator and conveying machinery in general cement-plant work. Location, Pennsylvania. 949.

RECENT ENGINEERING GRADUATE to take up economy studies in pole line and cable-plant construction; one experienced in estimating the cost of such construction given preference. State experience and salary desired. New York concern. 952.

SALESMEN on machine tools to represent large New York exporting corporation in China, Australia and South Africa. 964.

DESIGNERS. Men experienced in steam-engine and turbine work prefered. Location, East Pittsburgh. 967.

DRAFTSMAN familiar with power-house work, installation of equipment, piping, etc., and competent to work out different problems involved from general outline, without need of more or less constant supervision. Salary $25 to $28 per week. Location, New York. 969.

DRAFTSMEN experienced in design of chemical plants or machinery. Salary $30 to $50 per week, depending upon experience and ability of man. Location, New York State. 982.

MECHANICAL ENGINEER with technical education and at least five years' experience at plants manufacturing chemicals; work to be mainly advisory engineering in connection with manufacture of chemicals. Location, Delaware. 991.

MATERIAL SUPERINTENDENT wanted before October 1, by Chicago machinery manufacturer, at initial salary of $200 per month; will be responsible for all factory functions with exception of maintenance of equipment, training hands, tool designing, process inspection; will be immediate subordinate of works manager, and have to compete with one man for advancement. Give education and physical condition in detail; name firms, nature of duties, and number of months spent in each capacity. Location, Illinois. 992.

DRAFTSMAN on structural steel. Experience in powder, coal plants, industrial plants, power houses, layout, etc. Location, New York. 1011.

EXPERIENCED PUMP DRAFTSMAN for checking and detailing. Steady work, pleasant surroundings. Location, Middle West. 1021.

DRAFTSMAN for patent office drawings. Salary $25 to $35. Location, New York. 1022.

DRAFTSMAN to make measurements and drawings of machine tools; work will require considerable time and position has good promise for future. Young man desired with technical education and some practical experience, especially in machine-tool work. Location, Buffalo. 1033.

ASSISTANT to mechanical laboratories; prefer technically trained man, who would be able to conduct classes and look after equipment of shops of mechanical laboratories. Salary $120. Location, Brooklyn. 1060.

TECHNICAL GRADUATE capable of undertaking the standardization of materials and processes in large, small-tools manufacturing plant. Must be familiar with chemical and physical testing of metals and other materials, and with mechanical operations. State age, experience and references. Location, Philadelphia. 1087.

DRAFTSMEN having three and five years' experience on boiler and stoker work. Location, New York. 1090.

DRAFTSMAN capable of doing accurate checking on drawings. Location, Virginia. 1093.

METALLURGIST for firm making steel automobile parts, one of the largest in its field; familiarity with modern chemical and metallographical control essential. Must have sufficient initiative to lay out proper methods and the necessary personality to see that those methods are followed. Location, Pennsylvania. 1094.

DRAFTSMAN on piping and general machinery. Salary $20-$35. Location, Connecticut. 1099.

COMBUSTION ENGINEER familiar with large steam plants. Experienced in efficiency work. Location, Philadelphia. 1102.

DRAFTSMAN and ESTIMATORS for work of varied character with large concern. Offers good opportunity for advancement. Location, New Jersey. 1104.

DRAFTSMAN, technical graduate, capable of assuming full responsibility of drawing room, designing tools, fixtures, jigs, gages. One having shop and executive experience preferred. Location, Ohio. 1105.

PRODUCTION SUPERINTENDENT with experience in foundry and machine-shop work. Technical graduate 30-45 years of age preferred. Must be good executive, alert and aggressive in getting work through factory. Shop has approximately 800 men and does all kinds of power-transmission work. Location, Middle West. Salary $3000-$4000. 1106.

TECHNICAL GRADUATE wanted to do mechanical drafting and assist in other work in factory. In answer state age, education, past positions, and salary expected to start. Location, New Jersey. 1111.

MECHANICAL-ENGINEERING DEPARTMENT of a Middle West State college desires applications from men suitable for the position of foreman in machine shop. Successful applicant must have had several years' actual machine-shop work and be familiar with methods of mass production and scientific management. Desirable that he have college training, although not absolutely necessary. Should have had experience as foreman or assistant foreman in some successful shop, and preferably some teaching experience, although this is not absolutely necessary. Prefer young man not over 35 to 40 years of age. Location, Michigan. 1112.

DESIGNER of tools and jigs for large, high-grade factory, to build up a new department. Must have experience in heavy motor-truck work and first-class motor manufacture. An unusually good opportunity for the right man. Give complete information in first letter. Location, Middle West. 1114.

ENGINEER OF TESTS, to assume charge of physical testing laboratory of large corporation. Excellent opportunity for technically trained man with from two to four years' experience in testing work. In first letter state age, education, experience in detail, and salary expected. Location, vicinity of New York City. 1117.

SUPERINTENDENT of boiler house and power house in connection with blast-furnace plant. Location, Ohio. 1118.

MECHANICAL ENGINEER. Experienced in design of apparatus for chemical plants. Capable of working from rough sketches and other data. Salary $125 per month. Location, New Jersey. 1125.

PRACTICAL EFFICIENCY ENGINEER, not theoretical, for manufacturing company in Ohio. 1126.

MEN AVAILABLE

Only metmbers of the Society are listed in the published notices in this section. Copy for notices should be in hand by the 15th of the month, and the form of the notice should be such that the initial words indicate the classification. Notices are not repeated in consecutive issues.

WORKS MANAGER or SUPERINTENDENT in moderate-size plant, with view to making permanent connection. Technical graduate, age 31. Wide experience in purchasing materials, employment of all classes of labor, design and layout of factories, and installation of scientific production methods, standardization, and management in various industrial plants. At present employed as industrial engineer by large Eastern manufacturing corporation; work nearing completion with this concern after six years service. G-245.

WORKS ENGINEER or MANUFACTURING SUPERINTENDENT, experienced in modern manufacturing methods, and capable of getting maximum production from equipment and men employed. G-246.

PRACTICAL FOUNDRY MAN. Capable of handling any foundry position. G-247.

CHIEF OPERATING ENGINEER for large central steam-electric power company or holding company. Age 44, married. Twenty years varied experience in steam generation and utilization and design and installation of systems up to 7000 boiler hp. and 2500 kw. Thoroughly conversant with the principles and practice of economy in steam generation and utilization. Good organizer; university graduate. At present employed. References given. Location preferred east of Mississippi River. G-248.

MECHANICAL ENGINEER, with extensive all-around experience, desires change. Charge of mechanical engineering, design or mechanical superintendent. Heavy-machinery and industrial-plant experience. G-249.

SUPERINTENDENT of CONSTRUCTION or MECHANICAL ENGINEER. Specialty: plant construction and maintenance, installation of all power-plant and shop machinery, buildings, foundations, etc. Fifteen years' engineering experience in the West. Technical graduate, age 34. Desires a live job, any location. G-250.

MECHANICAL ELECTRICAL ENGINEER. Columbia graduate. As sales manager or superintendent. At present employed as manager of a very large concern. Experience in internal-combustion engines, gas producers, power installations, foundry and machine-shop practice and marine-power plants. Unusual business and technical training. Fully conversant with French, Italian and Spanish. Minimum salary to start, $4,000. G-251.

MEMBER. Technical, practical, with twenty years' broad experience in design, construction and operation of steam-electric power plants and transmission systems. Good executive. Has shown economy in steam generation with both anthracite and bituminous coal. At present with railroad near New York as engineer of power, light and heat. Desires position as superintendent or chief engineer of electric or steam-power system of large inland power plant, or in ore or coal-mining regions, South or West. G-252.

MECHANICAL ENGINEER. Age 35, married. Wide experience in the design of automatic and general machinery; also experience in general structural work, engine and boiler testing. Familiar with shop methods and following-up work through shops. Desires position with a firm in the Eastern states, preferably Philadelphia. At present employed. First-class references. G-253.

MECHANICAL ENGINEER. Married. Technical education. Thirteen years devoted to experimental work, education, development and production work on internal-combustion engines and self-propelled vehicles. Specialty, internal-combustion engines. Familiar with modern shop practice; can handle men. Open for a position with view of permanent connection. Highest references. G-254.

TECHNICAL GRADUATE, M.E., married, age 27. Shop experience, factory inspector, branch manager, sales experience. Now engaged in safety-engineering work. Desires position as assistant to executive or in sales department. Location preferred in East. G-255.

GENERAL PRODUCTION and FACTORY EXECUTIVE. Age 32, married. American. Technically trained, clean-cut and aggressive. Ten years' active experience in layout, organization and supervision of manufacturing projects along efficiency lines. G-256.

EXECUTIVE, MUNITIONS MANUFACTURE. Age 38. Twenty years' experience in almost every capacity, in Corliss-engine manufacture; as works manager recently organized, equipped and operated shop of 1000 men and successfully completed contract for artillery ammunition. Rejected by Engineer Officers' Reserve Corps on account of slight physical defect. Desires position where experience and ability will be fully utilized on the "big job." Present otherwise satisfactory position not directly useful to United States now. G-257.

GRADUATE IN MECHANICAL ENGINEERING. M.I.T. '15. Fourteen months' testing experience with a large electrical concern and some production experience. Desires work along production engineering or works-management lines. At present employed. G-258.

SALES ENGINEER, electrical-mechanical, technical graduate, age 34, married, American citizen. Twelve years' sales experience. Speaks Spanish and Portuguese. At present located in Cuba as consulting engineer, desires position in the United States, preferably in the West. Thoroughly acquainted with Denver, Salt Lake and San Francisco terrritories. Possesses executive ability, has specialized last seven years in electrical machinery, although has thorough knowledge of steam engineering. G-259.

PURCHASING ENGINEER. Presently engaged, would consider change for responsible position. Especially equipped through service with large organizations, and in technical and commercial valuation of materials, electrical and mechanical equipment, machine-shop processes, and building construction. G-260.

YOUNG MECHANICAL and ELECTRICAL ENGINEER. Technical graduate, age 28. Four years with large manufacturer of internal-combustion engines, steam pumps, compressors, gas producers, generators and motors. Two years assistant inspector of gas and electricity in a large city. Practical shop and engineering experience. Sales or engineering position with a future desired. G-261.

DIRECTOR or PRINCIPAL of TRADE or VOCATIONAL SCHOOL. At present head of department technical high school. Six years' practical experience, seven years' teaching. Desires to locate where ability counts and greater opportunity for advancement exists. Present salary $1750. G-262.

CHEMICAL and MECHANICAL ENGINEER. High-grade technical graduate in mechanical engineering who has also had thorough chemical training desires to change from present employment to position in a chemical industry where ability to operate economically, improve and develop methods will be appreciated. Sixteen years' experience, seven in chemical industry. G-263.

EXECUTIVE or ASSISTANT SUPERINTENDENT. Technical education, American, age 36. Practical mechanic, familiar with design of special machinery, tools, jigs, fixtures, etc., for manufacturing duplicate parts on interchangeable system. Twelve years in drafting room, including chief draftsman; six years' shop experience, one as foreman. Salary $2000 per annum. Location preferred, Eastern States. G-264.

WORKS MANAGER or SUPERINTENDENT. American, age 43. Twenty-two years' practical experience in interchangeable-parts manufacture, automatic and semi-automatic machine design and manufacture, power-plant equipment such as valves, piping, brass, gray and malleable iron fittings, tools and fixtures. Successfully held the positions of apprentice, tool maker, general foreman, chief draftsman, mechanical engineer and superintendent. At present employed; best reason for changing. Minimum salary $4,000. G-265.

YOUNG ENGINEER. Technical graduate. Two years' good engineering experience, desires position in engineering sales or purchasing department of manufacturing concern. G-266.

STRUCTURAL and MECHANICAL ENGINEER. Age 33, technical graduate. Six years' experience in designing structural steel and reinforced concrete. At present employed. Desires permanent and responsible position, in either executive or engineering departments, where past experience can be utilized. G-267.

SALES ENGINEER. Technical graduate. Six years' experience in steel work. Three years' experience in selling cast iron and cast steel. Desires position as salesman for large foundry; has large clientele and can produce gratifying results. G-268.

ENGINEERING SURVEY

A Review of Engineering Progress and Attainment in Mechanical Engineering and Related Fields, Including a Digest of Current Technical Periodicals and a Selected List of Engineering Articles

Recent Papers on Engineering Research

In view of the peculiar importance now attaching to engineering and scientific research and the very general desire to know more of the nature, purpose and progress of such work, it has been thought advisable to present here brief synopses of certain of the papers and addresses that have appeared in the last year or so in American and foreign periodicals. The list of articles so abstracted, however, should not be considered in any sense an exhaustive one.

J. J. CARTY CONTRASTS INDUSTRIAL AND SCIENTIFIC RESEARCH

In his presidential address to our sister society, the American Institute of Electrical Engineers, presented at the annual meeting in Cleveland in June 1917, J. J. Carty made an attempt to direct attention to certain important relations between purely scientific research and industrial scientific research and to point out how manufacturers of various types might avail themselves of the advantages of research.

The stupendous upheaval of the European war with its startling agencies of destruction, the product of both science and the industries, Mr. Carty said, has brought about a great awakening of our people, out of which has come a growing appreciation of the importance of industrial scientific research, not only as an aid to military defense, but as an essential part of every industry in time of peace.

Industrial research conducted in accordance with the principles of science is no new thing in America. The Research Department of the Bell Telephone Companies, founded nearly forty years ago, and which is under the direction of Mr. Carty, has grown from small beginnings with but a few workers to a great institution employing hundreds of scientists and engineers. The larger electrical manufacturing concerns have also founded industrial scientific research laboratories, and while vast sums are spent annually upon industrial research in these laboratories, Mr. Carty states that he can say with authority that they return to the industries each year improvements in the art, which taken altogether have a value many times greater than the total cost of their production. Money expended in properly directed industrial research, conducted on scientific principles, is sure to bring to the industries the most generous return.

Industrial scientific-research departments can reach their highest development in those concerns doing the largest amount of business. The conditions today are such that, without coöperation among themselves, the small concerns cannot have the full benefits of industrial research, for no one among them is sufficiently strong to maintain the necessary staff and laboratories. The small manufacturer may, however, obtain the full benefits of industrial research by taking his problem to one of the industrial research laboratories already established for this very purpose. If this be extensively done, such laboratories would be enabled to extend and improve their facilities so as to render better service, but until the manufacturers themselves are aroused to the necessity of action in the matter of industrial research, there is no plan which can be devised that will result in the general establishment of research laboratories for the industries.

In the present state of the world's development there is nothing which can do more to advance American industries than the general adoption by our manufacturers of industrial research conducted on scientific principles.

In the minds of many there is confusion between industrial scientific research and purely scientific research, particularly as the industrial research involves the use of advanced scientific methods. The distinction is to be found not in the subject-matter of the research, but in the motive. Industrial research is always conducted with the purpose of accomplishing some utilitarian end. Pure scientific research is conducted with the philosophic purpose for the discovery of truth and for the advancement of the boundaries of human knowledge. With all this, however, it must be borne in mind that the two are closely interrelated.

While a single discovery in pure science, when considered with reference to any particular branch of industry, may not appear to be an appreciable benefit, yet when interpreted by the industrial scientist—which includes the engineer and the industrial chemist—and when adapted to particular uses by him, the contributions of pure science, as a whole, become of incalculable value to all the new industries.

Mr. Carty strongly emphasized the fact that while discoveries of the pure scientist are of the greatest importance to the higher interest of mankind, their particular benefits are usually indirect, intangible and remote; and he showed how, through the utilization of American universities, means may be provided for an adequate establishment of scientific research in this country. (*Proceedings of the American Institute of Electrical Engineers*, vol. 35, no. 10, October 1916)

W. R. WHITNEY MAKES PLEA FOR RECOGNITION OF RESEARCH AND LIBERALITY TO WORKERS

In an address delivered at the alumni dinner of the Massachusetts Institute of Technology, January 6, 1917, W. R. Whitney, Director of the Research Laboratory of the General Electric Company, made an urgent plea for the better recognition of the value of scientific research work and a more liberal treatment of those engaged in this pursuit. He emphasized particularly how generally the world's greatest discoveries have been disclosed in their first stages by men who were highly trained and experienced in experimenting. The foundations of advance are most often made by such men as experimental-science professors, who with minds skilled in observation and keen in appreciation, have had opportunity to long continue the investigation of some phenomena of nature which they observed.

More chemists and physicists should be trained in our schools than are absorbed in our industries. They are needed much more generally in scientific-research laboratories in the college or elsewhere, where the country's future interests are

concerned. An investigator of the type of Faraday may be safely said to be worth thousands of ordinary men. It is necessary to recognize clearly that the great industrial development has not grown out of an accident or a single observation, but has been the result of painstaking work. It was a professor at Louvain, Minckelers, who apparently started us in the use of illuminating gas. He was not aiming to illuminate houses, but was trying such gases in balloons. He also tried lighting his lecture room by this means. Engineering development from this peculiar discovery did not take place for ten or more years, but it was the inquisitive mind of the trained physicist and chemist which made the engineering possible.

There are many more just such widely interesting developments which only await the careful study of the trained inquirer. Very little or nothing seems to have been accidental. Our position has resulted from gradual accretions of knowledge from many experimenters.

The speaker cited many cases where proper encouragement given to scientists had led to the development of important contributions to engineering in the broad sense of this term. (*General Electric Review*, vol. 20, no. 2, February 1917)

CHARLES P. STEINMETZ WANTS TO SEE RESULTS INDUSTRIALLY USEFUL

Industry, and with it all our modern civilization, depends on engineering, says Charles P. Steinmetz, Chief Consulting Engineer of the General Electric Company. Engineering, however, is nothing but applied science, and science thus is the foundation and scientific research the ultimate means which have created our civilization. Of late the industrial development has been so rapid and the demand for the results of scientific research so great and urgent that universities, which for ages have been the chief homes of scientific research, have not been able to supply it and the industries had to enter the field of scientific research themselves. Besides, universities and educational institutions rather retrograded in scientific research, became submerged in a false commercialism, which figured the output of the college in student-hours per professor, judged efficiency by the percentage of students graduated, and too often wasted the university's best assets, its professors. Thus we find in colleges men who have shown themselves capable as investigators to do scientific research work of the highest order, overloaded with educational or administrative routine and deprived of the time for research work. Private industries rarely commit such crimes of wasting men on work inferior to what they can do; industrial efficiency forbids it.

Thus, when the advance of industry demanded a more rapid extension of our scientific knowledge, scientific-research laboratories were established in the industries and some of them very soon showed their ability to produce scientific work of high character. But these scientific-research laboratories of the industry represent only a part, often a minor part, of the research work done within the industry, and in many places opportunity is afforded for the right men to carry out scientific research. Thus, in the materials testing laboratories of our industrial corporations, in their standardizing laboratories, development sections, etc., research work is being carried out and, as a rule, is encouraged by the corporations.

Under the head of industrial-research laboratories come also the commercial testing laboratories, development laboratories, etc., which have been established and serve the same purpose to the smaller industrial organizations as do the private laboratories to the great industrial corporations.

Theoretical scientific-research work in industrial establishments should be of such character that it may lead to results which are industrially useful. Actually, however, there is no scientific investigation however remote from industrial requirements which might not possibly lead to industrially useful developments. Indeed, experience has shown that it is rare that some industrially valuable results do not follow sooner or later, no matter how abstruse and remote from apparent utility a scientific investigation may appear. To illustrate—when the General Electric Company undertook research work on the electrostatic corona and dielectric phenomena in the air, no immediate or direct benefit could be seen for the company. But before the research was completed it had led to a redesign of practically all high-voltage transmission apparatus and has thus proved valuable in industrial design.

Some kinds of research can be carried out more efficiently by educational institutions, and others by the industries. Research requiring little in facilities, but a large amount of time and attention from research men is especially adapted to educational laboratories, while investigations requiring large amounts of material or of power rather than time of the investigators, are specially adapted to the industries, and often beyond the facilities of the educational institution. The best plan is a division of research between educational and industrial laboratories in accordance with their facilities wherever possible; as, for example, was done in an investigation of the phenomena of the dielectric field by the Consulting Engineering Laboratory of the General Electric Company on one hand, and Johns Hopkins University on the other.

The closer relation of industrial research laboratories to engineering practice leads to a tendency which, in general, may be expressed by saying that in the results of industrial research a probable error is greater, but the possibility of a constant error less. On the other hand, in industrial research the liability exists of limiting the work to such a narrow field that it has little general scientific value. Inversely, in educational research there is sometimes the tendency to generalize beyond the limits justified and so draw wrong conclusions. The quality of the work is about equal in both, and in the industry may vary from scientific research of the highest quality down to investigations which are of little, if any, value.

The essential difference between industrial and educational research, however, is found in their method of publication. The publication mediums of scientific research carried on in educational institutions are the scientific publications, while the publication mediums of the scientific research carried on in the industry are the technical or engineering papers. Unfortunately, a large number of scientists still look on publication in the technical press as unscientific, and as a result a large and steadily increasing part of the scientific research of the country is practically lost to the scientist. In one case certain tables of physical constants, published only a few years ago, neglected to take account of a mass of data on an important subject that had been recorded in engineering proceedings. Such an attitude of our scientists constitutes, in the opinion of Mr. Steinmetz, a serious menace to our Nation's progress. (*General Electric Review*, vol. 20, no. 2, February 1917)

CLAYTON H. SHARP ADVOCATES INDEPENDENT RESEARCH LABORATORIES

In discussing the position of independent laboratories in the engineering industries Dr. Clayton H. Sharp, Technical Director, Electrical Testing Laboratories, New York City, calls attention to the fact, which is becoming more and more clearly recognized, that with the sharpened competition which must

ensue at the close of the war any and all means for increasing our industrial efficiency will be considered with far greater seriousness than ever hitherto.

The great American manufacturing organizations realize the importance of laboratory testing and research and have provided means for carrying it on, but the manufacturers of smaller resources do not make a correspondingly large use of laboratory assistance. This may be ascribed to two causes: First, because they are not so fully aware of their own need for laboratory assistance and of the possibilities of laboratory work in increasing their efficiency; second, because of particular difficulties in securing such laboratory facilities as correspond to their needs.

Pure scientific investigation may be best carried on in the university, but for the adequate pursuit of industrial research work it is necessary to look to organizations constituted differently. The smaller manufacturer might take his laboratory problems to a technical school for solution, but this plan is open to the objection that the funds of the institution, being given for a public purpose, should not be diverted to private ends. Against this it may be urged that it is to the advantage of the technical school to take on a certain amount of industrial work, not only in research but also in testing. Such work necessarily brings both instructors and students into contact with certain practical problems of the outside industrial world, a world of which they know much in theory, but often too little in practice.

There are, however, certain disadvantages in having industrial problems handled by the technical school. The lack of contact with the actualities of practice, on the part of instructors and students who handle the problems, greatly lessens the value of the technical school as an organization for industrial research. The technical-school men are not equipped to consider the problems of cost, of the intellectual and psychological limitations of workmen, of transportation, of market conditions, of company policy, of technical and commercial usage in the field, any or all of which may have their influence on the result.

It is the independent laboratory that has to provide for the smaller manufacturer what the private laboratory does for some of the great corporations. To fulfill these functions properly, the independent laboratory must be adequately supported, properly manned and abundantly equipped. Its staff must be organized on particular lines. Its engineers must be familiar with the practical and commercial features, as well as the technical details of the work which they encounter. It must include physicists and chemists accustomed to look at the fundamental features of the problems presented. The fees charged by such a laboratory must be adequate to cover not only all expense but also to yield a sufficient profit as well.

In return the laboratory must deal with its clients in a highly confidential manner, conserving individually all of the results of the work for which they are paid. It must be prepared to turn over to its clients the inventions and patents which are the direct outcome of any specific piece of work.

The equipment of such a laboratory must be extensive to enable it to handle the great variety of work afforded to it. A very large supply of electrical power is an absolute requisite. To some extent a laboratory of this sort must possess from its very inception a considerable investment for its equipment. All this makes the establishment of such laboratories a matter of considerable difficulty, notwithstanding the great importance of the results which they may achieve for the industry. (*Journal of the Franklin Institute*, vol. 183, no. 2, February 1917)

ALBERT H. HOOKER CITES NIAGARA FALLS WORK

In a paper presented before the American Electrochemical Society on February 11, 1916, Albert H. Hooker, Works Manager of the Hooker Electrochemical Company of Niagara Falls, New York, presented a paper on Niagara, the Commercial Research Laboratory of the Nation.

In this paper the very significant statement is made that when the Niagara Falls Power Company started their tunnel about 1891, not one of the products now made by the company's use of power was then known to commerce. Aluminum, carborundum, alundum, silicon, artificial graphite, calcium carbide, cyanamide, various ferroalloys, sodium, chlorine, chloroform, etc., are all commercial products of the last 25 years, most of them having been developed through the impetus given by this Niagara Falls power development.

The vast importance of these products has scarcely been fully realized. Carborundum, alundum, aloxite, crystolon are all artificial abrasives used in modern grinding machinery for the manufacture of automobiles, guns, shells, shoes and for the grinding of tools. There is hardly an industry where the tremendous decrease in production and increase in cost would not be felt, were we without these artificial abrasives produced by the electric furnace at Niagara.

There are many vast problems in this connection and not in a day, a month, or even a year can these problems be worked out, the equipment developed and installed, and above all the workers trained. (*Metallurgical and Chemical Engineering*, vol. 14, no. 5, March 1, 1916)

MARSTON T. BOGERT DESCRIBES WORK OF CHEMISTRY COMMITTEE OF NATIONAL RESEARCH COUNCIL

In a preliminary statement to the American Chemical Society, M. T. Bogert gave some data on the National Research Council and its Chemistry Committee.

The main object of the National Research Council is, as its name suggests, to aid the cause of scientific research in every way possible. During the period of the Civil War the Federal Government often felt very keenly the need of expert advice in scientific matters of all kinds, and it was to meet this end that Congress, on March 3, 1863, by special enactment created the National Academy of Sciences. The present war has again shown with startling vividness to what extent the military power of a nation is dependent upon its scientific and industrial preparedness. The first step in this direction was made by the Naval Consulting Board of the United States with the coöperation of the 30,000 members of the great national engineering and technical societies. This board took a census of our industrial resources. The next step necessary was a proper classification of the census of the scientific-research resources of our country, and the body to whom the Government naturally turned for assistance was again the National Academy of Sciences. This latter, at the request of the President of the United States, has organized the National Research Council.

As regards the work of the Chemistry Committee, the present report calls attention to the fact that the vast majority of important scientific problems concern more than one science. There is, therefore, great need of some agency which will aid research workers, who wish to do so, to coöperate more intelligently. It is believed that the general committees of the Council can perform this service acceptably and thus act as accelerating catalysts to the growth and development of our science by becoming great clearing houses for the chemical research work of the country and authoritative headquarters

for information likely to be of value to the individual investigators, to our industries, and to our Government.

It should be stated most emphatically that the object of the Council and its committees is to assist, and not to direct. It has no desire or intention to interfere in the slightest with the freedom or initiative of the individual investigator, or to attempt to "organize and coördinate" him. In fact, the Chemistry Committee prefers not to receive any information which cannot be disclosed to any loyal American chemists. Those who are willing to place at the service of our Government confidential information of any kind should communicate direct with the secretary of the appropriate department or with the Director of the Council of National Defense.

The report proceeds to point out in which way the Council can hope to accomplish what is not being adequately cared for already by existing agencies. In the first place, the Council with the assistance of the Research Committees it is organizing in all of our leading educational institutions, can aid in obtaining for an investigator better recognition on the part of the community and of his own institution and an amelioration of his lot, by securing for him more freedom and better equipment for research, adequate assistance and a living wage. A deliberate and carefully considered recommendation by an authoritative body, such as the National Research Council, with the weight of the National Academy and of the Federal Government back of it and based upon information gathered by committees of leading experts, cannot be lightly passed over and is apt to be productive of results.

Thus the Council might well point out to our educational institutions the shortage of men properly equipped for high-grade research work in science; the fact that young men are being drafted into the industries, by present high wages, as soon as they are graduated and before they have had any special training in research; that the future is being handicapped by the loss to these same industries of so many inspiring teachers and investigators; the need of new advanced textbooks and reference works in science in our own language; of colleges and schools devoted to highly specialized training and instruction in relatively narrow fields of pure or applied science; and of great scientific research endowments, like the Rockefeller Institute of New York, and the Mellon Institute of Pittsburgh.

One of the first tasks confronting the Council is that of securing an accurate and properly classified list of the scientific investigators of the country; showing where they are located, in what lines of research they are interested, and how their work can be aided and encouraged.

The plan adopted for accomplishing this is to send out a questionnaire to all our educational and research institutions, and it is particularly requested that all chemists who receive such questionnaires from the American Chemical Society, the National Research Council or from any of their committees, will fill them out and return them promptly to the proper office. The data received in reply will be sorted out and classified in the office of the general committee and then forwarded to the chairmen of the appropriate sub-committees. The chairmen of these sub-committees will thus be put in possession of all information relating to their own particular fields, and will be then in a position to determine how best to help their fellow-workers. Reports on the situation in each branch of science will come periodically to the office of the general committee, together with recommendations and suggestions from the heads of these sub-committees concerning important investigations now under way or which should be initiated.

The committees of the Council are already of great assistance in bringing together the problem and the man best qualified to attack it. Both the Government and our industries are frequently entirely at a loss as to who are the proper men to consult when important research problems confront them. On the other hand, many skillful investigators are delighted to find that certain of these same problems, of whose very existence they have remained in blissful ignorance, fit in admirably with the kind of research work they enjoy most, and the fact that the problem has direct practical bearing imparts to the work added zest and charm.

Another form of coöperation which will help in meeting this same difficulty is that inaugurated by the University of Illinois and which has since been introduced at other institutions giving instruction in chemical engineering. Briefly stated, it consists in having the chemical engineering students, for their summer work, manufacture fine chemicals for sale to investigators in other institutions. The students thus get practical experience in the manufacture of chemicals, receive pay for the work, and the product is sold at its approximate cost. This does not in any way invade the territory of the commercial manufacturing chemist, for the reason that the chemicals so produced by the universities will be only those which are used in such small amounts that they are of no interest to the manufacturer. Through the Chemistry Committee of the Council, duplications in this work can be reduced to a minimum, each institution producing a different list of research chemicals for which it has provided the requisite equipment, and the Committee can then tell an investigator at once to which institution to apply for the special chemical desired. (*Journal of the American Chemical Society*, vol. 39, no. 5, May 1917)

A RESEARCH DEVELOPMENT IN ENGLAND

As an illustration of the development of research in England, we read in *The Engineer* for February 16, 1917, that the Advisory Council of the Government's Department of Scientific and Industrial Research has added to the list of its technical committees a Standing Committee on Glass and Optical Instruments.

The Committee met on December 11, and having regard to the urgency of the problems requiring investigation in respect to these essential industries, appointed a series of sub-committees to which various special problems were referred. Among these problems the more important are:

a Raw materials for glass and glass making
b Optical properties of a large range of glasses
c General physical and chemical properties of glass and glassware for scientific and industrial purposes
d Testing and standardizing of glassware
e Workshop technique
f X-ray glass properties
g Optical calculations and lens designing
h Optical instruments
j Translation of foreign works on optics.

This brief description indicates certain lines of investigation which have been brought forward. The Standing Committee does not propose to limit itself to these subjects, but is prepared to consider and report upon the necessity for investigation in other directions, relevant to its terms of reference. Manufacturers who have experienced difficulties requiring investigations for their solution in connection with the subjects of glass and optical instruments or who desire to make suggestions for special researches on these subjects are invited to communicate in the first instance with the Secretary of

the Research Department, Great George-street, Westminster, S. W., who will direct the correspondence into the appropriate channels for attention.

ALFRED SAXON FORESEES AGREEMENT ON RESEARCH NEEDS

In a paper read before the Manchester Association of Engineers on February 10, 1917, Alfred Saxon, who is a representative of the society in question on the British Standing Committee on Engineering, said that, with reference to industrial research in mechanical engineering, the scheme was likely to take the form of certain well-defined sections of the trade being brought together and agreeing as to the researches that were the most necessary and desirable, each firm joining being asked to contribute towards the cost, assisted by a government grant. He considered that the value of the scheme to practical mechanical engineering would depend largely upon whether the government was prepared to assist until the research schemes became self-supporting by the contributions of the firms themselves. He urged that all firms would act wisely by making provision in future for an outlay on research work as a standing charge. Inasmuch as mechanical engineering was the key industry to all the industries, the need of scientific research to assist in the creation of new ideas and new methods and to reduce manufacturing costs and prevent waste of material was overwhelming. (*The Engineer*, vol. 123, no. 3190, February 6, 1917)

ROBERT KENNEDY DUNCAN AND HIS NOTABLE RESEARCH PLAN

No synopsis of papers on industrial research in America would be complete without a quotation from some work by the late Prof. Robert Kennedy Duncan. First as professor at the University of Kansas, then in a broader field of activity at the University of Pittsburgh, Professor Duncan did yeoman work in making available for the American industries such means of research as there were. His work was largely responsible for the establishment of the Mellon Institute of Research at the University of Pittsburgh, which not only did and is doing useful work itself, but served as an example in the recent establishment of a system of research coöperation between technical schools and industries in Australia.

In 1906 Professor Duncan published his Chemistry of Commerce, the object of which, as he stated in the introduction, was to convince the manufacturer, through instances taken here and there, how absolutely applicable is modern science to the economy and progress of manufacturing operations.

At that time he preferred against American industries the grave but nevertheless largely true charge that in our country, astonishing to say, success in many cases has been achieved actually by working in accordance with the motto, "Save at the spigot and waste at the bunghole."

Professor Duncan early realized the tremendous importance of the German system of research as an element in industry and often expressed his ideas in a striking manner. "The Badische Anilin und Soda Fabrik of Ludwigshofen am Rhine" is a name to conjure with in Germany, and no robber castle on that historic river was ever more dreaded than is this modern fortress of industry by those against whom it is commercially and inimically inclined. It was in England in 1831 that Peregrin Phillips discovered that sulphur dioxide and air would unite with the most agreeable ease in the mere presence of platinum. However, nothing came out of this discovery in England, because there was no sympathy there between learning and manufacture. In Germany, on the other hand, there was no tariff wall against English ideas and the matter was taken up. Difficulty after difficulty arose, and plan upon plan went to the scrap heap. They found they were using little air when they ought to use much; they found they were using heat when they ought to use cold; they found that platinum was being constantly poisoned by impurities in the roasted gas. But after an enormous expenditure of knowledge and time and labor and money, they won. The roasted sulphur gas and air are scrubbed and dried and cooled and passed over platinized asbestos, only to be collected therefrom as sulphuric acid—more than 200,000 tons in 1904. And all this has added significance from the fact that here a highly valuable product is obtained through the utilization of a by-product, the waste sulphur from the zinc blend. Here the enormous dividends paid by these companies attest the profitable nature of the application of pure science to industry.

The industrial fellowship was one of the solutions of the problem as to how the American manufacturer might secure the benefits of the highest grade of research at a reasonable cost. The scheme proposed was to have a special research department in the university. The company which desires a certain problem investigated endows an industrial fellowship or fellowships for a period of one or more years. The exclusive purpose of such fellowship is the discovery of improvements in the particular branch in which the donor is interested, and the holder of the fellowship gives his whole time and attention to that particular problem.

The fellow is appointed by the university authorities. He is a member of the university and pays all regular fees, works under the advice and direction of the professor in his department, and periodically forwards through this latter the reports of the progress of his work to the industrial company which donated the fellowship.

All the discoveries made by the fellow during the tenure of his fellowship become the property of the company, subject to the payment by them to the fellow of one-tenth of the net proceeds arising from such discoveries.

The concluding words of Professor Duncan's book may be worth recalling at the present time:

"Everywhere throughout America, wherever there is the smoke of a factory chimney, there are unsolved, exasperating, vitally important manufacturing problems—problems in glass, porcelain, starch, tanning, paints, drugs, meats, iron, oil, metallurgical products—problems wherever man deals with substance. It seems clear that these problems can best be answered by combining the practical knowledge and the large facilities of the factory with the new and special knowledge of the universities, and by making this combination through young men who will find therein success and opportunity.

"A Temporary Industrial Fellowship does this: it affords a young man every incentive to lay his hands on the vast body of correlated knowledge called Science, and to make it subserve the practical needs of the human race."

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The Society for the Promotion of Engineering Education has cancelled its meeting planned to be held at Northwestern University, and will hold its 1917 annual meeting in Washington, July 6 and 7, in connection with the Educational Committee of the Advisory Commission of the Council of National Defense. The topic of the meeting will be The Relation of the Engineering Schools to the National Government during the Present Emergency.

New Tidewater Tin-Plate Plant

It is expected that the first unit of the new tin-plate plant now being built for the Bethlehem Steel Company at Sparrows Point, Maryland, will be ready for operation by July 1.

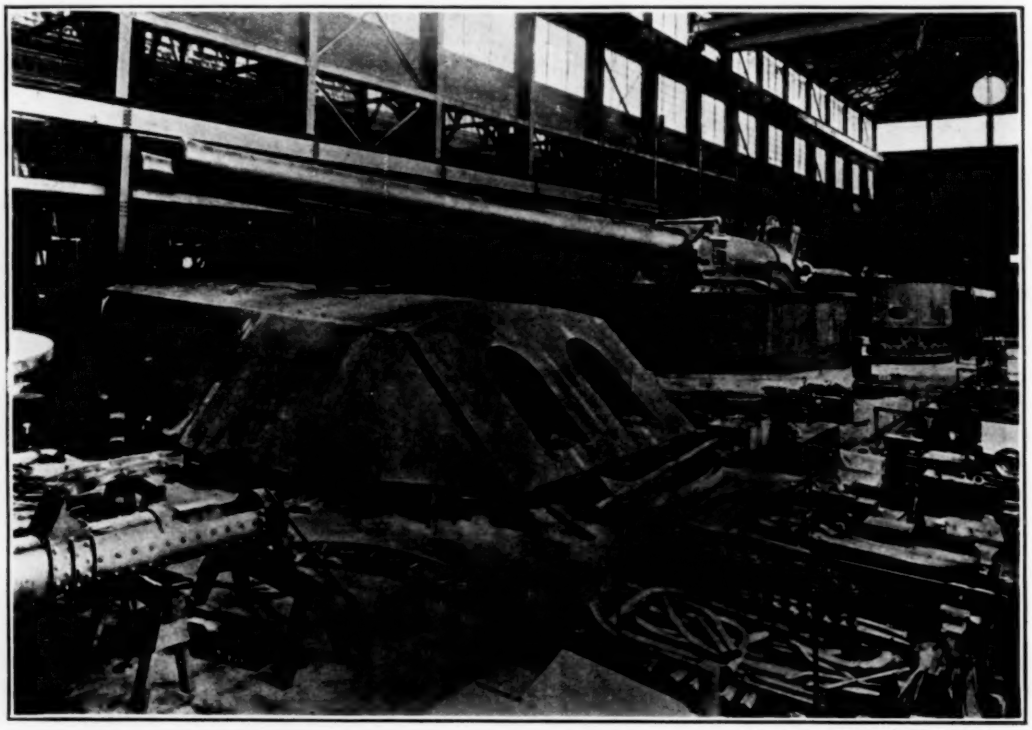
This plant forms part of the tremendous construction program recently undertaken by the Bethlehem Steel Company in various sections of the country. The Sparrows Point plant was formerly operated by the Maryland Steel Company and the tin-plate works will form another link in the growing chain of steel products manufactured by the Bethlehem Steel Company. It is laid out for an eventual production of 2,000,000 base boxes annually. The initial unit of 12 mills now nearing completion will have, however, a production of only 1,000,000 base boxes of tin plate a year.

The buildings are of permanent and fireproof construction and of generous size throughout. Although only twelve mills are being installed at present, the buildings, foundations, etc., have been completed for the eventual twenty-four mill layout.

Some of the drives used are of considerable interest. The hot mills, which are of very massive construction, are divided into two main groups of six each, each group being driven by a 1200-hp. motor designed to operate on 2200-volt, 25-cycle alternating current. The motors are connected to the hot-mill spindles by means of cast-steel cut helical reduction gears. The speed reduction is eight to one.

The cold-rolling department consists of 12 stands of 24 by 36-in. cold rolls driven in tandem of three by a rope drive and a 1200-hp. motor. The Wuest herringbone reduction gear is interposed between the motor and the rope pulleys. The rope drive is inserted in the power-transmission system in order to be sure that the sheets will leave the mill with the most desirable surface possible, and it is believed that a rope drive tends to give a better surface to sheets than a rigid gear drive.

In connection with the above description, attention is called to the accompanying photograph, very recently taken (Underwood and Underwood) and not published elsewhere, of the gun-machinery room of the Bethlehem Steel Company.



Underwood and Underwood

Gun-Machinery Room of Bethlehem Steel Company

Work of American Colleges and Universities During the War

The report has been received of a meeting held in Washington, May 5, of college presidents, called by Dr. Hollis Godfrey, Chairman of the Advisory Commission of the Council of National Defense on Science and Research, including Engineering and Education. The object of the meeting was to formulate a comprehensive policy for coöperation between the higher institutions of learning and the Government and to determine a general policy to be pursued by the American colleges and universities, so that their resources would be available, to the fullest extent, for Government service.

In a statement of principles issued, it was held, first, that all young men below the age of liability for selected draft who could avail themselves of the opportunities afforded by our colleges should do so in order that they might later be able to render the most effective service. Second, that the colleges should consider the advisability of dividing the college year into four quarters of approximately 12 weeks each, and that, where necessary, courses be repeated at least once a year so that the college course might be best adapted to the needs of food production. Third, that students pursuing technical courses, such as engineering, would render more valuable service by continuing their training than if they were to enroll in military or naval service before graduation. Fourth, that the colleges should include as a part of their course of study, teaching in military science in accordance with the provisions of the National Defense Act of June, 1916.

Resolutions were passed looking to coöperation between the Government and the colleges, by which means the latter would

be kept informed of the plans of the Government in its various departments for the prosecution of the war, in so far as they concern the work of the colleges; and of the extent and type of technical or military training which it may seem desirable to the Government that the colleges should undertake.

A committee was appointed by the Chairman to serve as a special section on education of the Committee on Science, Engineering and Education of the Advisory Commission, which took preliminary steps toward the accomplishment of results indicated by the resolutions at the main meeting.

Notes from the Engineering Colleges

Equipment of Laboratories—Investigations in Progress—Changes in Curricula

BELOW is a continuation of the review of professional work being undertaken at the engineering colleges. The articles contain information regarding (1) characteristics of laboratory equipment, (2) tests or researches under way or in prospect, (3) important changes in curricula.

The articles will be concluded next month.

ARMOUR INSTITUTE OF TECHNOLOGY

Equipment: The laboratory equipment differs very little from that of institutions such as Cornell or the University of Illinois. Special equipment for research work in automotive engineering, refrigeration, heat transmission through insulating materials, fan blowers, and lubrication.

Experimental Work: Specialization in testing automotive engines and appliances; work for commercial concerns; method of testing internal combustion engines; testing various materials for use in connection with Government work.

BROWN UNIVERSITY

Equipment: Usual college apparatus, to handle mechanical tests of materials up to 400,000 lb. in tension, compression and cross bending and to 60,000 in.-lb. in torsion. Especially well equipped with auxiliary measuring apparatus and with means for measuring power.

Experimental Work: Determination of causes affecting precision of machine tools; study of electric high-temperature heating furnaces for industrial purposes. Plans under consideration for closer coöperation in matters of instruction between the University and the industrial establishments of the community.

Curriculum: Entire revision of the engineering curriculum has been authorized by the Board of Fellows to go into effect next fall, as the result of a careful study by a large committee of engineers and educators. The new course is designed to develop the broader type of engineer. It has come about as a result of the demand for engineers trained in the fundamental sciences and their applications, with power to express themselves with clearness, accuracy and force; and with a knowledge of human relations to enable them to enter executive offices and industrial organizations as well as to direct the work of construction ordinarily expected of an engineer.

Under the new curriculum the student may either take a course which will fit him for a broad choice of positions; or, if he is to specialize, he can postpone specialization until he has had an opportunity to determine the field for which he is best fitted. He will not be forced to an early decision as to the particular branch of engineering which he is to pursue.

Throughout the course emphasis is placed on the fundamentals of science and engineering together with such applications as may be necessary to drive home the principles and give the engineering point of view. Courses which give mainly information easily secured while on practical work after graduation are either eliminated or made elective. Subjects fundamental to all branches of engineering are required of all students, but opportunity will still be given for specialization in civil, electrical and mechanical engineering for those who desire it. Engineering courses are introduced in the freshman and sophomore years to parallel the courses in mathematics and physics and to give an opportunity to apply the theories to actual problems. Foreign languages as a requirement are eliminated, although they may be elected. The course allows considerable flexibility in the choice of subjects. The requirements are as follows:

Freshman Year: Trigonometry, analytic geometry and elementary calculus; mechanical drawing, first semester; descriptive geometry, second semester; surveying and engineering mechanics; rhetoric and composition; chemistry or substitute; during part of the summer vacation a course in either surveying or shop work will be required.

Sophomore Year: Differential and integral calculus; economics and either social or political science; physics, mechanics and graphics, English or approved substitute.

Junior Year: Mechanics and structures; electrical engineering; heat and power; materials of engineering, first semester; hydraulics, second semester; approved elective.

Senior Year: Engineering economics, report of special investigation, two engineering electives, two approved electives.

The electives include advanced surveying; railroad engineering; geodesy; highway engineering; structural design; water supply and sewerage; advanced electrical engineering, direct and alternating currents; traction engineering; transmission engineering; shop practice, organization and management; machine design; power plant engineering; gas power engineering; experimental engineering; conference courses in heating and ventilation; refrigeration, fire protection, etc.; mathematics, chemistry, physics; French, German, Spanish or Portuguese; English, public speaking, history, philosophy, social and political science and economics; the entrance requirements are unchanged.

KANSAS STATE AGRICULTURAL COLLEGE

Equipment: For testing materials, a 200,000-lb. Olsen universal testing machine, a 250,000-in.-lb. torsion testing machine, a 100,000-lb. and a 50,000-lb. Riehlé testing machine, a 10,000-lb. beam testing machine, cement and concrete testing equipment, two impact machines, a hardness testing machine, equipment for testing bituminous road materials, etc.

The equipment includes also a number of dynamo electric machines, a compound steam engine of 50 hp., 12 steam engines with different types of valve gears, three steam turbines equipped with condensers; pumps; a Smith suction gas producer, which supplies gas to a 25 hp. Foos gas engine and can be operated either with producer gas, natural gas, water gas or with light and heavy liquid fuels; 30 other gas and oil engines, one 3½-ton Frick compression machine for refrigeration, one ½-ton York compression machine and one 2½-ton horizontal compression machine, equipment for testing trucks and traction engines.

Research Work, Tests: Concrete and aggregates, insulation for electrical conductors, lightning arresters, machine tools, heating and hardness tests on metals, Kansas molding sands.

Investigations: Refrigeration; sewage disposal; uses of electricity in the home; oil engines and oil traction engines, automobile motors, lubricating oils for automobiles, properties of paints, thermodynamic investigations on steam and internal-combustion engines. Members of the engineering faculty are encouraged to take up investigations of value to the profession, which are carried on under the auspices of the engineering experimental station.

Curriculum: The engineering courses are being revised as the college is changing from the three-term plan to the semester plan. In this connection a study has been made of the time devoted to the various subjects in thirty of the leading engineering colleges. In the new courses of study these results will be incorporated.

Lewis Institute

The Cement Users' Association makes use of the strength of materials laboratory for its investigations in cement and other materials entering into concrete construction, while the Institute continues to use the laboratory for the purposes of instruction. This arrangement has proved very satisfactory. The students are showing interest in the work of the laboratory, and there seems to be a stimulus to good work in the presence of this busy, scientific workshop.

New Mexico College of Agriculture and Mechanic Arts, School of Engineering

Equipment: This is a typical land grant college, with emphasis in its course in experimental and extension work in agriculture and engineering. The agricultural experiment station is conducting work regularly along improvements in methods and efficiency in this state. The organizing of an engineering experiment station is now under consideration.

Experimental Work: Considerable experimental work was done on arc welding and testing of brick; it is hoped materially to increase this research work and particularly to do work of help to the United States Government.

Curriculum: In addition to the regular engineering courses, it is planned to give a six weeks' practical course in highway construction and concrete, to further the good road movement; also to give a practical six weeks' course in electricity, automobile mechanics and tractor operation, the use of the tractor in New Mexico being still in its infancy. A one-year short course in automobile mechanics proved very successful last year.

Oregon Agricultural College

Equipment: Apparatus for testing materials, cement, etc.; highway, hydraulic, steam, oil and gas engines; fuels and oils; metallography of iron and steel, including some special apparatus for tests in power transmission, on insulating materials, and on heating and ventilating equipment.

Experimental Work: In addition to the regular instructional work this department does the laboratory work for the Oregon State Highway Department and during the past year the majority of the special tests have been on Oregon highway and bridge materials.

Pennsylvania State College School of Engineering

Equipment: A thermal testing plant which includes refrigerating apparatus, and a heating system; a separate building thoroughly insulated in which is a second insulated compartment for tests of the transmission of heat through simple and compound walls (additional apparatus is being installed to provide for accurate automatic regulation of temperatures), and a steam laboratory equipped for the testing of steam, gas, kerosene and oil engines of various types and capacities. There is also a completely equipped flour mill for experimental and research work, as well as for class instruction, and a separate building equipped for the study of causes of explosions in flour and cereal mills, with firing apparatus, instruments for the detection of static electricity, and special apparatus for the prevention of the propagation of flame from mills to storage bins.

Experimental Work: On the loss of heat through glass as influenced by wind velocity, humidity and difference in temperature; explosiveness of various mixtures of flour milling materials, and possible sources of ignition; economy of oil engines of the 20-hp. semi-Diesel type; on the life of various types of electric lamps; and relative fire protection offered by unpainted board surfaces, surfaces painted with common white lead and oil, and surfaces painted with a fire resisting special paint.

The study of the explosiveness of various flour-mill dusts has shown that where separate sources of ignition are provided, such as electric arcs, in the attrition mill, explosions could be produced at will, and of an intensity that seemed to indicate that the destructiveness would depend upon the quality and quantity of material ignited.

Rose Polytechnic Institute

Equipment: The institute has just completed a very successful campaign whereby means have been provided for the erection and equipment of its new plant, which contemplates a removal of the entire institute within the next two years. The new site lies two miles outside of the city limits, and will occupy a campus of one hundred and twenty-two acres. The plan to be carried into effect provides for complete new equipment as well as new buildings.

The laboratory equipment includes a 200,000-lb. Olsen testing machine, a 100,000-lb. Riehlé testing machine with recording apparatus, a 32,000-lb. special testing machine, a 100,000-lb. beam-and-column testing machine, a 10,000-lb. chain-, rope- and wire-testing machine, a 4-in. continuous torsion-testing machine, three cement-testing machines with complete apparatus for cement testing, wire-testing machine for elasticity, etc., an alternating-stress machine, continuous and integrating indicators for steam and gas engines, indicator-testing machines, transmission and absorption dynamometers, tool-cut dynamometer, 6-in. journal-friction machine, traction dynamometers for cars and engines, Kelvin electric balances for standardizing wattmeters, volt and ammeters, electrostatic voltmeters up to 100,000 volts, apparatus for testing insulating materials; testing instruments and transformers; dividing engine and comparator for length standardizing.

Experimental Work: Construction and test of hydraulic shunt flow tube; study and comparison of the road resistance of various road-building materials, especially with reference to automobile traffic; relative strength of square and filleted corners; effect of humidity conditions on the power production of gasoline engines; experimental investigation of aluminum-

chromium alloys; efficiency test on internal combustion engines; electric hysteresis test and losses in iron; strength tests on bridge members; utilization of wood waste; utilization of city garbage.

Sibley College, Cornell University

Equipment: The mechanical laboratories consist of the following:

The Materials Testing Laboratory, which is equipped for tension and compression tests with an Olsen 300,000-lb. machine, a Riehlé 100,000-lb. machine, a 200,000-lb. Emery hydraulic machine; for transverse tests with a Riehlé machine of 200,000 lb. capacity and a Fairbanks machine of 10,000 lb. capacity. There are two Thurston autographic torsion machines, one Olsen torsion machine of 200,000 in.-lb. capacity, and two Upton-Lewis fatigue testing machines.

The Steam Laboratory, which comprises a 150-hp. triple-expansion Allis-Corliss engine and several smaller engines. There is a 35-kw. horizontal Curtis turbine and a 15-kw. De Laval turbine, an Ingersoll-Rand compressor and three air-brake pumps of different types, a 150-hp. Babcock & Wilcox water-tube boiler of marine type, and one 100-hp. Babcock & Wilcox water-tube boiler of standard type, an 80-hp. Heine water-tube boiler and a 25-hp. Roberts safety boiler connected with a Foster independent superheater.

The Gas Engine Laboratory, including gas engines, gasoline engines, and hot-air engines.

The Hydraulic Laboratory, containing centrifugal pumps, water wheels and hydraulic rams; water meters and other auxiliaries.

The Oil Testing Laboratory, Refrigeration Laboratory, Cement Laboratory, Fuel Testing Laboratory, which are similarly equipped.

The electric equipment includes a Dynamo Laboratory, Standardizing Laboratory, and a Wireless Laboratory.

Work Shops include a foundry occupying floor space of about 4800 sq. ft., a forge shop with the usual equipment of standard forges and small tools, a pattern shop with floor space of 8440 sq. ft.; the machine shop has the same floor area as the pattern shop. It is equipped with an electric traveling crane and representative modern machine tools. A part of the workshop equipment is installed to illustrate the latest practice in production with specialized labor-saving machinery.

Washington University (St. Louis)

Equipment: Laboratories are equipped to do research work on fuels, gas and steam appliances, automobiles, etc., and especially equipped for testing cutting tools.

Research Work: Tests have been made on steam-turbine nozzles, automobiles, kerosene carburetors, and high-speed steel cutting tools, but the work was not all completed owing to the seniors carrying on the work being excused for military duty. In the tests on cutting tools particular attention was paid to the effect on the life and power of the tools when the lip and front angles were varied. In cutting soft steel the best results were obtained when using a lip angle of 25 deg. and a front angle of 14 deg. In the carburetor tests it was possible to operate a 9 by 11-in., 300 r.p.m, two-cylinder, four-cycle Bruce-Macbeth gas engine on various mixtures of kerosene and water and of kerosene and gasoline. The experiments were not carried far enough to arrive at any definite conclusions as to the best mixtures to use.

Sheffield Scientific School, Yale University

Equipment: General teaching and research laboratories in physics, chemistry, mechanical engineering, electrical engineering, mining engineering, cement testing. The mechanical-engineering laboratory is equipped to handle problems relating to motor vehicles, steam and gas engines, house-heating boilers, and the testing of materials. The mining laboratory has special facilities for investigations in the fields of ore dressing, metallurgy and metallography.

Research Work: Testing of house-heating boilers (Journal A.S.M.E., Nov. 1916); commercial sampling and analysis of producer gas (Journal A.S.M.E., Dec. 1916); hardness tests on brass[1]; shearing strength of heat-treated steels; power losses in pneumatic tires (Bulletin S.A.E., Feb. 1917); grinding brass ashes in the conical ball mill (N. Y. Meeting, A.I.M.E., Feb. 1916); tests on the Hardinge conical mill (St. Louis Meeting, A.I.M.E., Oct. 1917); comparison between electrolytic and two varieties of arsenical Lake copper with respect to strength and ductility in cold-worked and annealed tests (Trans. A.I.M.E., 1916); growth of grain and diffusional characteristics on annealing bronze containing from 4 to 8 per cent tin (International Ztsch. für Metallographie, Oct. 1916); tests with various aggregates and sands; survey of sands in the vicinity of New Haven, Conn.

Industrial Research: Some investigations were conducted under a coöperative agreement with certain manufacturers. A similar arrangement is described by Professor Mathewson in his paper Coöperation with Metal Industries in Metallographic Work (Am. Inst. of Metals, 1916). As it may be of interest to manufacturers and other engineering schools, a brief outline of it is as follows:

> A graduate student whose undergraduate work in this or other universities shows promise of ability to handle research work, is chosen by conference between the company and instructor involved. The aim of the company in the agreement then entered into is to obtain the solution of one or more of the technical problems with which it may be confronted, or, at the end of one or two years, to obtain as an employee a man especially trained in its work. As a means to accomplish one or both of these ends, the company furnishes the machine, apparatus, or material to be tested and pays the student during his graduate work a small salary, usually just sufficient to cover his living expenses, tuition and fees. The aim of the student is special training along a line in which he is particularly interested, the attainment of his advanced degree, and the chance to show to his future employer ability to handle such problems as may be presented to him. In return for the financial aid which he receives he agrees to devote at least half of his working time to the special problem submitted by his company. The other half is devoted to study of the collateral subjects required by the department for the granting of the degree which the student seeks. The student further agrees to enter the employ of the company in question at a wage not greater than that paid in like positions to recent graduates not specially trained and to remain with his employer at such wage for at least 1 year. If the student is to obtain a degree, the special work forming the basis of his investigation must be such as will involve real research and not mere routine manipulation. The subject is chosen by conference between the three parties to the agreement. The work is carried on under the direct supervision of the instructor involved. The school furnishes the general laboratory and library equipment essential to the pursuit of any extended investigation. In return it is expected that the results of the investigation shall be, in part at least, available for publication, if they are deemed of interest to the profession.

Tulane University of Louisiana

Experimental Work: The College of Technology has well-equipped laboratories. Investigations have been made of

[1] *American Machinist*, May 31, 1917.

pumping-plant equipment under the auspices of the U. S. Department of Agriculture, and results have been reported from time to time in the bulletins of that department and in papers before the Society. Commercial tests of metals, woods and cements are frequently made. Other work touches on heat treatment of steel, reported in the *Journal of the Iron and Steel Institute;* physical tests of bricks manufactured in the States of Louisiana, Mississippi and Alabama, published in the *Transactions of the American Society for Testing Materials;* and drainage-pumping plants.

Department of Industrial Chemistry: Researches are made on local manufacturing problems, and it is endeavored to meet the peculiar demands of the locality in this respect.

West Virginia University

Equipment: Machine, woodworking, forge, sheet-metal and pipe shops and foundry.

Steam Laboratory: High-pressure boilers, separately fired superheater, simple and compound engines, steam turbine and condensers of different types; apparatus for testing separators, drop in line pressure, flow of steam, testing indicators, gages, etc.

Testing Material Laboratory: Testing machines ranging from 20,000 to 400,000 lb.; complete equipment for testing highway materials, cement and concrete; Brinell and Shore hardness-testing equipment.

Hydraulic Laboratory: Not extensive but well adapted to instruction work and for a limited amount of research work. Well equipped for measuring flow of streams.

Mining Laboratory: Well equipped for first-aid and rescue work, coal calorimetry and coal analysis; analysis of mine air, etc.; furnace work, mining machinery.

Oil and Gas Laboratory: Fitted up especially for testing lubricating oils and petroleum and for the extraction of gasoline from dry natural and casing-head gas.

Electrical Laboratory: Especially well equipped with dynamo-electric machinery of various types, transformers, rectifiers, condensers, high-tension apparatus and electrical instruments, electric-railway equipment.

Research Work: Combustion of natural gas under boilers and the heating value of natural gas; tests on West Virginia building brick in coöperation with the American Society for Testing Materials; drop in pressure in pipe lines, using differential manometers; correct form and location of sampling tubes for steam-calorimeter work; effect of superheat and change of vacuum on the economy of steam turbines; effect of varying percentages of carbon on the hardness of steels; flow of steam in pipes; distribution of concentrated loads on concrete slabs; crown thickness for concrete arches; study of slag concrete; curves for run-off of streams in Monongahela Valley; standardization of bridges, and culverts for State Road Bureau; study of the distortion of the field of a salient-pole alternator at various power factors; effect of inertia on the performance of a phase converter; effect of orienting the molecules of a gas on the opacity of the gas to Roentgen rays.

The Mining Engineering Department is the official Bureau of Research for the State Department of Mines, and does all the analyses of mine air, etc. The State Road Bureau also uses the laboratories.

Curriculum: Chemical engineering has been added and the course in oil and gas engineering has been enlarged. The plan of continuous sessions will be adopted, enabling those who are physically fit to graduate earlier. By this arrangement the present junior class may graduate by December 15.

News of Other Societies

Institution of Mechanical Engineers

The annual meeting of the Institution was held on Friday evening, April 20, 1917. The President, Michael Longridge, gave the address.

The war had taught us many things, he said, but none more clearly than the importance of our engineering industry. Upon this industry we depended for victory today and for security and prosperity tomorrow.

The mechanical engineer was in no small measure responsible for the transformation of the industrial life of England, and he must also be held responsible for the maintenance and efficiency of the workshop on which the feeding of the people and the defense of the people against their enemies now depended. He became and he remained a trustee for the British Empire.

In the view of the speaker the British engineers had not fully done their duty. As an example, he quoted the story of the engine-building trade of Lancashire. There was a time when Lancashire's supremacy in this branch of engineering was beyond dispute. But when the speaker went to the Paris Exhibition in 1900, he found that in elegance of form, in completeness of finish, in careful arrangement of details, the engines exhibited by some of the continental countries excelled the British stationary engine. It was, however, only through the repeated loss of orders that much later British engineers were forced to recognize the esteem in which continental products were held by customers. Later still the time came when complete steam engines built abroad were brought to England, erected and set to work by foreign workmen, even in the very home of British steam-engine manufacture, in Lancashire itself.

Some of the causes of the relative retrogression of British mechanical engineering, Mr. Longridge said, were beyond the control of engineers. Others they could remove in part or altogether. And of these he named inefficient technical education, lack of trade organization, and the policy of the trade unions. (Abstracted through *The Engineer*, vol. 123, no. 3200, April 27, 1917, pp. 371-374, *g*)

Canadian Society of Civil Engineers

At a luncheon of the Ottawa Branch of the Canadian Society of Civil Engineers on April 26, 1917, Colonel David Carnegie, Ordnance Advisor to the Imperial Munitions Board, delivered an address on the manufacture of munitions in Canada and the permanent assets to Canadian industry resulting therefrom.

In September 1914, said Colonel Carnegie, when General Sir Sam Hughes undertook the first order for shrapnel shells, Canada's capacity to produce shells amounted to 340 18-Pr. shrapnel shells per week. These were made at the Dominion Arsenal, Quebec. The capacity of Canadian factories today approximates 400,000 18-Pr. shrapnel complete rounds per week, including cartridge cases, primers, fuses and propellants. In addition to this amazing output there is a weekly capacity in Canada for nearly 400,000 high-explosive shells, ranging in sizes from 18-Pr. to 9.2 in., making an approximate total weekly output of 800,000 shells. This large output, along with other supplies made independently, requires each week about:

25,000 tons of steel	200 tons of antimony
2,500 tons of brass	150 tons of resin
750 tons of copper	500 tons of cordite

250 tons of zinc	500 tons of trinitrotoluol
1,500 tons of lead	300 tons of nitrocellu-
Several tons of ferromolybdenum.	lose powder.

Over 300,000 boxes are required for these shipments per week, and about 3¼ million lineal feet of board are used in making these boxes.

The weekly value of these products can only be understood by people who have learned to think in millions.

The total value of orders for munitions placed in Canada approaches eight hundred million dollars, and the value of the munitions shipped is close upon five hundred million dollars.

When the first order for 200,000 empty shrapnel shells was undertaken no one had any idea of the magnitude of the work, the foundation of which was then laid. That order, which required over six months to complete, represented eleven years' work at the rate of output of the Dominion Arsenal. The present weekly output of 400,000 18-Pr. shrapnel shells from Canadian factories is equal to twenty-two years' output from the Dominion Arsenal.

The uncertainty of securing material for the first order, of the right quality and in sufficient quantity, together with the difficulty in obtaining machinery and skilled labor to produce shells which would pass inspection and gun proof, made even the most courageous manufacturer hesitate to undertake the work without having the assurance of the Canadian Government that they would bear any financial loss incurred in the venture.

Instead of placing orders for the complete shells with each manufacturer, an arrangement was made whereby manufacturers whose domestic trade most nearly approached that required in producing the component parts of the shells were asked to undertake the work. Such parts, when finally inspected, were assembled and finished at the works of other manufacturers, who had to install machinery and plant for the purpose. The manufacturers were therefore not called upon to carry the responsibility for the purchase and inspection of any of the materials used in the shells.

They were also supplied with a complete set of inspection gages to guide them in making or obtaining manufacturing gages and in the standard of finish required by the Government inspectors.

While the manufacturers were relieved of these responsibilities, the cost of production was reduced and the quality of output improved by purchasing the materials through one agency instead of many, and by standardizing the inspection of work in supplying the gages to all makers.

All manufacturers were paid the same price for the same work. No competition was admitted among them, except the rivalry to excel each other in making the largest output that would pass Government inspection. This policy united the manufacturers without restricting inventive skill, ingenuity of design, and new methods of individual works management. It promoted a spirit of comradeship among them and an exchange of visits to their works. Freely were new ideas for cheapening and improving the quality of production used by all.

One could hardly mention this subject without being reminded of the almost insuperable difficulties which were presented in the early days of the war in obtaining gages for munitions. Canadians could never thank the United States manufacturers sufficiently for what they did in coming to their aid at that time. The special skill in making gages to the limits of accuracy required could not then be found in Canada. Today there were at least twenty factories producing gages in Canada, and while they were not independent of help from the States, some idea of the magnitude of the work could be understood from the monthly bill, which amounted to over $150,000 for new gages.

During the month of March about 10,000 new gages and checks were imported, the usual accuracy called for on a gage being 0.0003 in., and for a check 0.0001 in. An army of over 5000 examiners was engaged upon inspection under the direction of Colonel Edwards and his staff of officers.

The Engineers' Club of Brooklyn

THE Engineers' Club of Brooklyn was addressed at its meeting of April 26 by C. E. Drayer, Secretary of the Cleveland Engineering Society, on coöperation between Engineering Societies and the Newspapers to Promote Intelligent Public Opinion. Successful methods of close coöperation with newspapers were described in detail, as developed during a period of five years or more in the Cleveland Engineering Society.

News arose, said Mr. Drayer, from happenings that people wanted to hear about. It was evident that engineering topics which could not measure up to this standard could not compel space in the papers. On the other hand, if the society was doing things which would interest the readers of the papers, the editor could not for long keep accounts of such activities out of his paper and hold his job. But the inferred premise was wrong that editors did not welcome engineering news. They were eager for it if the right kind was supplied. At once the suggestion arose that the best way to learn how to supply copy was to get familiar with the standards of news measurement of the successful editor. The methods found successful in Cleveland would apply equally well anywhere, for people would be found to be people—with very slight variations—everywhere.

Publicity, which had received so much emphasis of late, was a means only, not an end. The end was service to the community first, to the engineering profession second, with mutual profit. When the public learned that the engineer was honest and efficient, capable of administering its affairs better than now done, it would make short work of the old-time politician. The present widespread call for the city-manager form of government over the country was but a demand for capable government. It was a call for engineers, but not for the kind that were content with technical matters, but for men having technical training plus the determination of the lawyer to be a leader in the community and the mixing ability of the politician.

The speaker told of the activities of the Cleveland Engineering Society in building-code legislation, paving supervision and water supply for the good of Cleveland and predicted that the next mayor would be an engineer. He said there would be no dearth of engineering news and that the space in the newspapers would be freely open to engineers when they woke up to their opportunity and took what was awaiting the taking.

Using the Cleveland Engineering Society as an illustration of what could be done when engineers were united in a community, Mr. Drayer urged unity and federation of engineers of the United States after the manner of the Chamber of Commerce of the United States, and noted the wonderful influence of the American Institute of Architects, which, with a membership of but 1200, had nevertheless left its imprint on the nation more deeply than all the engineering societies, because it had been properly organized. He arraigned the recently formed

Engineering Council as missing its opportunity in that it was undemocratic, made no provision for fellowship and did not find its strength for directing legislation where men voted.

Shipping Pig Iron (Not Pigs) in Refrigerator Cars

"So short has been the supply of cars in the South that iron has been shipped to navy yards in refrigerator cars. These came loaded with iced beef, but were seized by the Government as the only available equipment and loaded out with pig iron."

This statement from a report of the iron market, issued by the Matthew Addy Company of Cincinnati, clearly indicates the serious shortage of rolling stock, when even the National Government must adopt such heroic measures as using refrigerator cars for the handling of pig iron.

In discussing the iron market in connection with this rolling-stock situation, the Matthew Addy Company's report says:

"It is apparent that Government needs and Government's right of eminent domain, so to speak, are going to have a profound effect on the iron market. They have introduced a new element into the situation and have made conditions more strenuous. In some districts Uncle Sam is requisitioning cars by the hundreds and ordering steel by the million tons; everywhere it is evident that the Government must be served first and that private consumers must sit at the second table. There is no objection to this. All realize that Uncle Sam is and must be paramount. But that does not change the fact that the private consumer is discommoded, and that in many cases he finds his regular source of supply abruptly cut off. And the thing has just begun. What the end may be is a mere matter of conjecture.

"This week there has been a great increase in inquiry. Demand for iron knows no limits. Part of this demand comes from the fact that iron that was bought has not been shipped, and if consumers cannot get what they have under contract, they must get it elsewhere. As an example of this, one of the large Birmingham producers has in 60 days piled to exceed 45,000 tons of iron on its yards simply because it is impossible to get cars in which to ship, as the Government has requisitioned 50,000 cars for coal and rails. And all the time consumers are clamoring for this very iron. So short has been the supply of cars in the South that iron has been shipped to navy yards in refrigerator cars. These came loaded with iced beef, but were seized by the Government as the only equipment available and loaded out with pig iron. It is things like these that bring to the mind the forcible realization of the fact that the railroads have fallen down in this great crisis. But the people who starved the railroads are the only ones to blame." (*Manufacturers Record,* vol. 71, no. 21, May 24, 1917, p. 47)

The *American Machinist* of May 31, 1917, mentions the receipt of a 600-page catalogue of the Lyons Fair which was held at Lyons, France, from March 18 to April 1 of this year. Considering the conditions under which this fair has been carried out, the *American Machinist* calls the exhibit nothing if not miraculous. Besides a comprehensive representation on a large scale that drew exhibits from practically all the industries of France and her colonies, many allied and neutral countries were represented. The machine tool section of the catalogue covers 14 pages, and among the representatives of the industry one notices the names of 15 American builders of machine tools.

This Month's Abstracts

At the present time, when the United States Government has under consideration the expenditure of hundreds of millions of dollars on aviation, the data on propellers abstracted from two papers by J. Lawrence Hodgson are of particular interest.

The description of a British continuous enameling and stoving machine is reported from an article in (London) *Engineering.*

L. R. Brown, in the *Engineering News-Record,* publishes data of some tests of sand in concrete showing the influence of the duration of tests on the results secured.

The abstract of a paper on the influence of temperature on the bending resistance of mild-steel and copper wires, originally published in the *Zeitschrift des Vereines deutscher Ingenieure,* is here reprinted from *Science Abstracts.* This is because German journals do not reach this country, but appear to be available in London.

W. K. Shepard, in an article on the hardness tests of brass, shows that the plotted relation between the scleroscope hardness number and the ultimate tensile strength for brass is parabolic (straight line for steel). On the other hand, no constant relation was found between the scleroscope and the Brinell hardness numbers for brass.

Attention is called to the article on the performance of lubricating-oil coolers by M. C. Stuart, Mem.Am.Soc.M.E. This article covers the relation between performance and the weight, volume and amount of cooling surface in various types of coolers.

The use of oscillographs for the study of internal-combustion engines, especially in regard to phenomena of ignition, described in the section Measuring Apparatus, deserves particular attention, as this instrument has proved to be an extremely valuable adjunct in the study of electrical machinery.

The Laws of Elastico-Viscous Fluids, by Prof. A. A. Michelson, will be found, in abstract, in the section Mechanics. The writer makes an attempt to formulate the behavior of substances under stress by the simplest expressions which have been found to satisfy all the essential requirements, and states that the behavior of any solid under stress may be considered as the resultant of four elements constituting the laws of elastico-viscous flow.

From papers and discussions before the recent Convention of the International Railway Fuel Association have been taken two abstracts on locomotive feedwater heating; one more or less theoretical, and the other of mainly an experimental character.

The still largely uncertain subject of circulation in flooded systems has been investigated by means of glass models, as described in an article abstracted from the May *A. S. R. E. Journal.*

The section Steam Engineering in this issue contains several abstracts of more than usual interest: Recent Installations of Large Turbo-Generators, a paper read by Richard H. Rice before the American Iron and Steel Institute, presents many data on the most modern practice, with estimates of costs in heat units and money. Another paper, by John A. Stevens, read before the Boston meeting of the National Association of Cotton Manufacturers, also gives data on turbine practice, and in addition presents a highly interesting description of a new type of boiler (Stevens-Pratt), so large that the length of the tubing, both in the boiler and the superheater, is measured in miles.

REVIEW OF ENGINEERING PERIODICALS

SUBJECTS OF THIS MONTH'S ABSTRACTS

Aeronautics

Tests on Model Propellers

Abstracts of two papers presented to the Institution of Automobile Engineers: the first entitled, The Characteristic Curves of a Propeller; and the second, An Experimental Investigation as to the Relation Between the Thrust Ratio of Lifting Propellers and the Number, Arrangement, Shape, Section and Pitch of Their Blades, both by J. Lawrence Hodgson.

The Characteristic Curves of a Propeller. The investigation was undertaken with a view to obtaining a general idea as to the performance of a propeller when it was moved at various speeds forward and backward along its axis of rotation, and to express this information in some simple way so that the approximate performance of any similar propeller working in a fluid medium of any given density might be readily deduced.

If, when comparing the performance of similar propellers working at the same slip ratio, the resistances due to skin friction and viscosity are assumed to follow the velocity-square law and change of density in the neighborhood of the propeller is neglected, there are six main features to be considered. These are, thrust in lb., T; revolutions per minute, N; torque in lb-in., q; speed of advance in ft. per sec., V; density of fluid in which propeller rotates in lb. per cu. ft., W; diameter of propeller in inches, D.

For given values of W and D, it is not possible to predict accurately by any simple theory the manner in which T, N and q will vary for different values of V. This may, however, be determined experimentally and expressed by means of curves. The experimental values may be obtained in three ways: viz., with T constant, or with N constant, or with q constant. In the experiments described in this paper the first way has been adopted.

If, instead of plotting the experimental values of N and q to obtain various speeds of advance for given values of W and V when T is constant, we plot non-dimensional coefficients which connect these values with two or more of the other variables, general curves are obtained from which the performance of any similar propeller under any conditions may be deduced. Such curves No. 1 and No. 2, Fig. 1, may be termed the characteristic curves of the propeller, since they entirely define its performance under any given conditions.

If the units in which the six variables are measured are consistent among themselves, these characteristic curves can be used without recalculation, but the curves in the present paper cannot be so used.

The propeller used for the present tests was 6.25 in. in diameter and had a pitch of approximately 6 in. Its blades were constructed of soft brass and attached to a central boss.

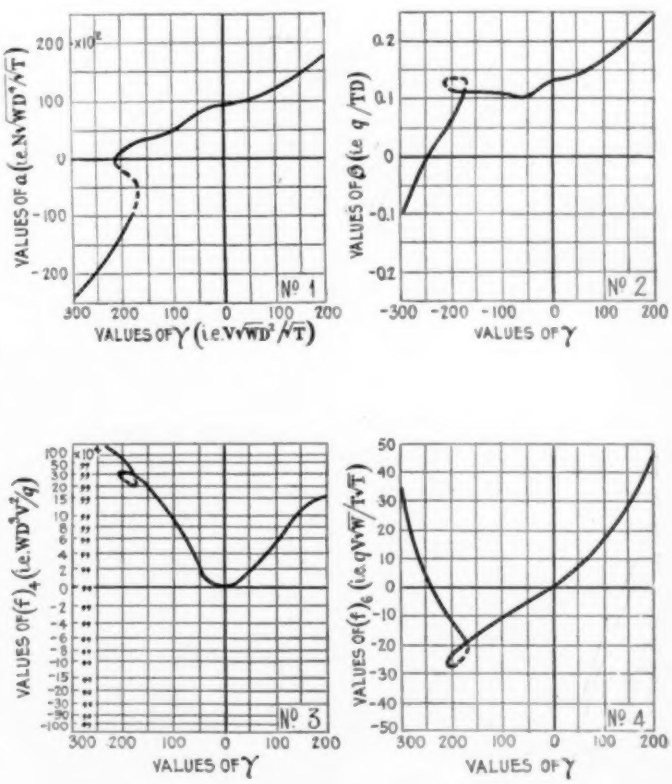


Fig. 1 Characteristic Curves of Propellers

All the tests were carried out in water, and the paper describes in detail the experimental apparatus and method of carrying out the tests.

A series of comparative tests taken in the same bell mouth with similar propellers 3 in. and 6.25 in. in diameter, respectively, showed that at comparatively small positive and negative speeds of advance the proximity of the walls of the bell mouth produced practically no effect.

The experimental results reduced to 1 lb. thrust for the 6.25-

in.-diameter propeller are plotted in curves reproduced in the original article.

The following special points of interest are brought out in these curves. It was found that when the speed of advance is negative, it is possible to obtain the same thrust at different torques and with the propeller rotating at widely different speeds. Further, it appears that the experimental mean pitch as determined from the lines of zero thrust (at zero thrust the experimental mean pitch multiplied by the revolutions equals the speed of advance) is greater when the fluid impinges upon the leading edge of the propeller than it is when the propeller is reversed and the fluid impinges upon the trailing edge.

These tests have indicated how N and q are related to V when T, W and D are constant. Under certain assumptions the variations of N, q and V with T, W and D follow quite simple laws for points on the curves for which the ratio V/DN is constant.

Coefficients α, β, γ, which connect N, q and V with the expressions involving T, W and D, are determined as follows:

Since $T \propto N^2WD^4$ for points for which the ratio V/DN is constant, we may write

$$N = \alpha\sqrt{\frac{T}{WD^4}}$$

whence

$$\alpha = N\sqrt{\frac{WD^4}{T}} \quad \text{[1]}$$

Also, since

$$q \propto N^2WD^5, \text{ or}$$

$$\propto \alpha^2 \frac{T}{WD^4} WD^5 \text{ by [1]},$$

we may write

$$q = \beta TD$$

whence

$$\beta = \frac{q}{TD} \quad \text{[2]}$$

Further, since for the points considered the ratio V/DN is to be constant, we may write

$$V \propto DN$$

$$\propto D\alpha\sqrt{\frac{T}{WD^4}} \text{ by [1]}$$

$$V = \gamma\sqrt{\frac{T}{WD^2}}$$

whence

$$\gamma = V\sqrt{\frac{WD^2}{T}} \quad \text{[3]}$$

In the foregoing, α, β, and γ are numerical coefficients which may be calculated from the experimental results.

Curves connecting α and γ and β and γ are plotted at (1), (2), Fig. 1.

These curves, if used in conjunction with equations [1], [2], and [3], enable us, if we know T, W and D and one of the variables N, q and V, to find either of the other two.

The paper proceeds to the discussion of certain problems which may arise in calculating propellers geometrically similar to the model used.

For the solution of such, in similar cases, the writer suggests the derivation of a number of additional equations and curves from the three equations and the two curves referred to above. Such equations are immediately derived by him and collected in a table in the original article.

Among other things, an equation is given for the calculation of the thrusts of the ideal stationary propeller. Further, data are presented showing how the value of the "thrust ratio" t, which is defined as the ratio of the actual thrust to the theoretical thrust, is affected by the number of blades, the blade section, the developed blade outline, the developed edge elevation of the blade, the designed pitch, and the angle between the chord and the aerofoil section and the plane of rotation of the propeller, this latter under the assumption that the pressure face of the blade is perfectly flat.

This is done in the second paper, which represents an experimental investigation as to the relation between the thrust ratio of lifting screws and the number, arrangement, shape and section of their blades. The paper is suitable for abstracting only in parts.

The writer found from an examination of the stream-line flow through a stationary propeller by means of smoke filaments that the minimum diameter of the slip stream is about 0.6 of the blade diameter. Further, the smoke filaments show that in the case of a propeller of the usual pitch ratio having thin blades of good aerofoil section, the rotation of the fluid set up is small. From this the author proceeds to establish equations for the calculation of the thrust of a propeller and the determination of factors affecting the value of the thrust ratio. From a large number of experiments it was found, among other things, that the value of thrust ratio is only very slightly increased by using blades of helical form.

Also an unexpectedly small diminution was found in the value of the thrust ratio consequent upon the rounding off of the leading edge of the aerofoil section. On the other hand, a great reduction was found consequent upon cutting down the blade outline and modifying the edge elevation. Likewise a great reduction was produced by adding round struts and wires to the propeller, but a quite high value of thrust ratio was found possible in the case of propellers strengthened by struts, provided that these are made of streamline form.

The broad conclusions from these tests, which were carried out with the object of obtaining data for the design of lifting propellers of large size, would seem to be that there is little advantage (except reduction of vibration) to be gained by constructing such propellers with more than two blades, or by making the blades helical instead of flat (if the blades are made flat, the longitudinal spars are much simpler). It would also appear to be quite practicable to use blades of thin aerofoil section stiffened up by exposed struts and wires of streamlike form. It is also advantageous to thin down the blades at the tip and along the trailing edge. So far as the experiments show, there seems to be but little to be gained by departing from blades of rectangular blade outline.

Higher values of τ might have been obtained by putting the "planes" considerably farther apart. But this would have been inadmissible in practice for constructional reasons.

A reference to the streamline diagram will show that it is preferable to place the motor or any other necessary obstruction to the flow on the intake side of the lifting screw so as to avoid undue loss of energy by friction in the high-velocity slip stream.

This point seems to be well understood by those who design electric fans and screw-propelled ships. It is, however, of far less importance in the case of an aeroplane propeller, owing to the high velocity of the aeroplane.

The same diagram also shows how necessary it is to "shroud" a circulating fan, such as a radiator fan, which is

required to produce a high velocity on the intake side. (*The Automobile Engineer*, vol. 7, no. 101, April 1917, pp. 90-95, 16 figs., *etA*)

Enameling

Continuous Enameling and Stoving Machine for Small Parts

Description of a machine manufactured in England for enameling and stoving a great variety of parts of different shapes and sizes by continuous mechanically effected rotation. It is stated that it has an output up to 2000 parts per hour, with the attendance of only two unskilled operators.

The machine consists of two distinct units: one, the painting or enameling machine, and the other, the stoving machine. The painting machine consists of a table on which is mounted a vessel in the form of a tube or tunnel through which the articles to be painted are passed at a uniform speed and at a uniform distance from each other by means of an endless chain and wheels driven by a small electric motor. Each part to be painted is hung on a specially prepared hook, and these hooks are so made that they insure the various parts being kept at an equal distance from each other. The speed at which these parts pass through the tunnel can be up to 2000 per hour, and the distance of each part from the other can be varied to suit the requirements. On each side of the tunnel are placed two or more pneumatic paint-spraying machines which operate through coned openings in the sides of the tunnel and are so disposed as to insure the paint from the sprays reaching all the surfaces of the article being painted during the passage through the tunnel. After passing through the painting unit each article is disposed automatically by the machine on a small rod which forms a connecting link between the two units of the apparatus.

The continuous stoving machine consists of a rectangular chamber about 16 ft. long by 4 ft. wide, heated by suitable gas jets and fitted with a sliding door at the rear end. Two continuous chains with suitable sprockets are provided, one on each side of the machine, and operated by a handle so arranged that at each revolution of the handle the chain travels longitudinally inside of the stove a distance of about 4½ in. These chains are provided to carry rods on which are suspended the parts which have been painted. Each rod travels through the stove at a rate equal to that of the number of revolutions of the handle. The result is that by the time the parts on any one rod have traveled through the whole length of the stove they will have been subjected to the heating for a definite period and the stoving operation completed. (*Engineering*, vol. 103, no. 2678, April 27, 1917, pp. 410-411, 1 fig., *d*)

Engineering Materials

Long and Short Sand Tests, L. R. Brown

The writer mentions a case where the results of a 7-day test of sand were so unfavorable that it was rejected. A 28-day test also showed the quality of the sand to be poor. The sand was, however, next tested with a different brand of cement and quite favorably passed the test at the end of half a year.

The writer believes, therefore, that probably the values of combinations of lake sand and cement found in the 7-day and 28-day tests are influenced by properties in the sand that hasten or retard the setting of the cement. Thus, a comparatively high value resulting from a mixture of sand and cement may be due to chemical action produced by the combination of certain chemicals in each that hasten the setting of the mortar, rather than deliver a neutralization of the injurious substances in the sand by the chemicals in the cement.

From his tests the writer comes to the following conclusions:

1 Nearly all well-graded sand has proved reliable on a 6-month test.

2 The reason for the low values obtained in the 7-day and 28-day tests is due to a delay in setting because of chemical properties in the sand or cement.

3 While changing the brand of cement used with a given sand may give higher values for 7 days and 28 days, the 6-month results may be lower.

4 The addition of small quantities of alkali to the mortar probably has only the effect of hastening the hardening of the mortar. (*Engineering News-Record*, vol. 78, no. 10, June 7, 1917, pp. 504-505, *e*)

Influence of Temperature on the Bending Resistance of Mild-Steel and Copper Wires, Lautz

An apparatus has been designed in which it is possible to effect the alternate bending of wires through an angle of 180 deg. while the specimen is heated at temperatures up to 320 deg. cent. in an oil bath. The results of a large number of tests show that the resistance of iron wires to fracture by alternate bending remains fairly constant up to 120 deg. cent. Between 120 deg. and 220 deg. the resistance increases rapidly, and above the latter temperature falls very abruptly. The maximum values are about double those observed at ordinary temperatures. In annealed wires the maximum is very pronounced, but it is nothing like so sharp in unannealed wires; further, it occurs at about 10 or 20 deg. higher in the unannealed samples. Contrary to expectations, copper broke quicker than iron at ordinary temperatures; the number of alternations rose continuously with the temperature. Bending around a sharp edge gives more reliable results than bending around a radius. The work is to be continued so as to determine the effect of variation in composition, and so on. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 60, pp. 785-788, September 23, 1916, through *Science Abstracts, Section A—Physics*, vol. 20, pt. 4, p. 122)

Experiments with Cold-Drawn and Annealed Ingot Iron, O. Bauer

A series of tests was made on cold-drawn and annealed ingot iron. The physical tests consisted of the determination of Brinell hardness, resistance to shock and tensile strength. The chemical examination consisted of solubility tests in 1 per cent H_2SO_4 for 70 hours and rust tests in 1 per cent NaCl for 30 days. It was shown that the solubility in acid gave better results in ascertaining the approximate annealing temperature than the Brinell hardness, and that as the annealing temperature rose, the solubility in H_2SO_4 diminished. The rust tests did not give satisfactory results, and there appears to be no distinct relation between the temperature of annealing and the rusting tendency of the Fe. (*Mitt. kgl. Materialprüfungsamt*, 33, 395-407; *Chem. Zentr.* 1916, I, 1281, through *Chemical Abstracts*, vol. 11, no. 11, June 10, 1917, p. 1625)

The Hardness Tests of Brass, William Kent Shepard

Data of an investigation made by the Sheffield Scientific School to determine the relation between the ultimate tensile

strength of brass and the hardness number as found by the Brinell and scleroscope tests.

Investigations of a nature similar to the present have been made on various styles, and in each case an appropriate straight-line relation was found to exist between the ultimate tensile strength and the hardness number, whether Brinell or scleroscope.

In this test annealed brass and brass that had been cold-rolled with reductions in thickness from 4 to 45 per cent of the original was used. It was all one grade, about 66 per cent copper and 34 per cent zinc. The data are presented in the form of tables and curves. It was found that the relation between the scleroscope hardness number and the ultimate tensile strength is parabolic for brass, and not a straight-line relation as in the case of steel. Likewise a parabolic relation was found to exist between the Brinell hardness number when determined by each different load and the ultimate tensile strength of brass.

The curves are tabulated to show also that there is no constant relation between the scleroscope and the Brinell hardness numbers for brass. In the curves the points are seen to be widely distributed along a general straight-line direction. (*American Machinist*, vol. 46, no. 22, May 31, 1917, pp. 935-937, 7 figs., *d*)

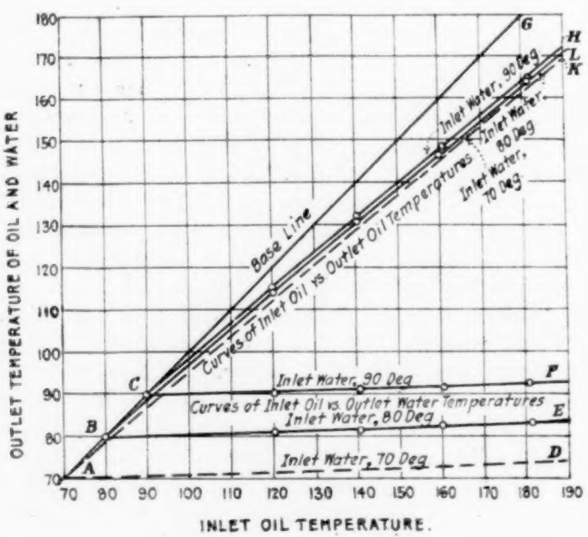


FIG. 2 TEMPERATURE DIAGRAM

Hydraulic Engineering

LOW-HEAD POWER DEVELOPMENT AT PRAIRIE DU SAC, H. W. Young

Description of a hydroelectric plant of the Wisconsin River Power Company, of 15,500 kw. capacity, representing recent practice in design of low-head waterpower development.

The construction and efficient operation of plants of the type of the one described here have been made possible through the progress of hydroelectric engineering in the last few years. Until quite recently, the difference in the mean low-water flow and the flood flow of a river has not been given due consideration. As a result, lack of sufficient spillways and adequate machinery to operate properly the flood outlets has endangered, to a great extent, all low-head waterpower developments where these conditions of flow existed. This feature had to be particularly provided for in the Prairie du Sac development, where the mean low-water flow is 5000 sec.-ft. and the high flood flow has reached 26,000 sec.-ft. This big difference has been taken care of by the installation of 41 Tainter gates, 14 ft. high and 20 ft. wide, placed on top of the spillway section of the dam. This permits control of all stages of floods and has a very important bearing on the present successful operation of the plant. These gates are all electrically operated.

The present normal head utilized is 28 ft., maintained the year around, as nearly as possible, by means of the control gates. In time of flood water, however, this is somewhat decreased by the backing up of the water in the tailrace, the loss of head from this cause being sometimes as high as 8 or 9 ft. (*Electrical Review and Western Electrician*, vol. 70, no. 20, May 19, 1917, pp. 828-833, 8 figs., *d*)

Internal Combustion Engineering

(See THE USE OF OSCILLOGRAPHS FOR THE STUDY OF EXPLOSION MOTORS in section Measuring Apparatus)

Lubrication

THE PERFORMANCE OF LUBRICATING-OIL COOLERS, M. C. Stuart (Mem.Am.Soc.M.E.)

A paper presenting the main data of tests carried out at the U. S. Naval Engineering Experiment Station at Annapolis. This paper covers the relation between performance and the weight, volume and amount of cooling surface in various types of coolers.

With cooler installed and a certain oil selected for use, the variables for the test are limited to quantities of oil and cooling water circulated, and oil and water temperatures. Hence the test is divided into two parts: first, runs in which the rates of flow of oil and water are maintained constant and the temperatures of the inlet oil and water varied; and second, runs in which the inlet temperatures are maintained constant and the rates of flow of oil and water varied.

In the first division of the test runs are made with inlet water of varying temperature, say, 80 to 90 deg. fahr., and at each inlet water temperature runs are made with varying inlet oil temperatures, say, 120, 140, 160 and 180 deg. fahr. The resultant outlet temperatures of oil and water are plotted on what is termed a temperature diagram. Fig. 2 shows the relations between all the temperatures involved in the performance of the cooler at constant rates of flow of oil and water.

This "temperature diagram" is a valuable aid in the analysis of the performance of oil coolers. As shown in Fig. 2, the abscissæ are inlet temperatures and the ordinates are outlet temperatures. A base line, or equal temperature line AG, is first drawn diagonally across the diagram. The values of inlet oil temperature versus outlet oil temperatures for the runs in which the inlet water temperatures were 90 deg., are plotted and line CH is drawn through the points. The intersection of this line with the base line at C is determined from the following consideration. Although the lowest inlet oil temperature was 120 deg., it is evident that if the inlet oil temperature should be reduced to the inlet water temperature, or, in this case 90 deg., the outlet oil temperature would equal the inlet oil temperature. In other words, the curve of inlet oil temperatures versus outlet oil temperature for a constant inlet water temperature intersects the base line at the temperature of the inlet water. In the same manner the curve CF of the inlet oil temperature versus outlet water temperature also intersects the base line at the inlet water temperature. The lines

BL and *BE* represent the results of runs made at inlet water temperature of 80 deg.

The important property of the temperature diagram is that the lines are straight, or very nearly straight, and the lines of a group are parallel. By means of this property curves may be constructed for other water temperatures than those covered in the test. Thus, in Fig. 2, the dotted lines *AK* and *AD* represent the outlet oil and outlet water temperatures, respectively, for an inlet water temperature of 70 deg.

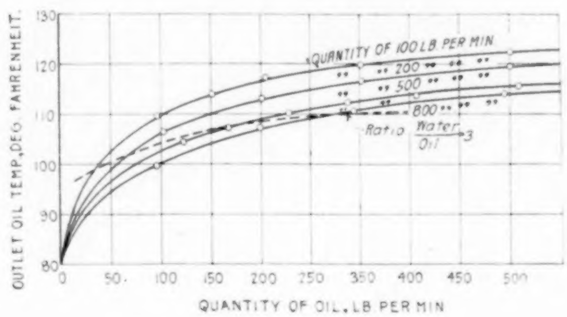


Fig. 3 Quantity Diagram

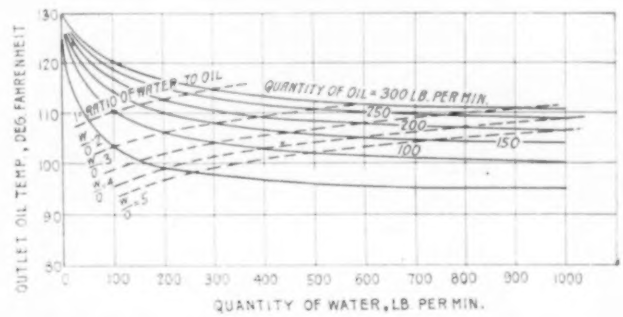


Fig. 4 Quantity Diagram in Fig. 3 Cross-Plotted

The writer shows how such a diagram may be constructed from data of a single run. The temperature diagram may be used to derive an analytic method of determining the relation between the various temperatures of the oil cooler. In fact, he establishes the following formula:

$$\frac{T_i - T_o}{T_i - t_i} = C$$

in which T_i = inlet oil temperature; T_o = outlet oil temperature; and t_i = inlet water temperature.

Data from a single run at given quantities of oil and water may be used to determine the value of flow. Then for any other conditions of inlet oil temperature and inlet water temperature the value of the oil temperature drop and outlet temperature may be found by substitution in the above equation.

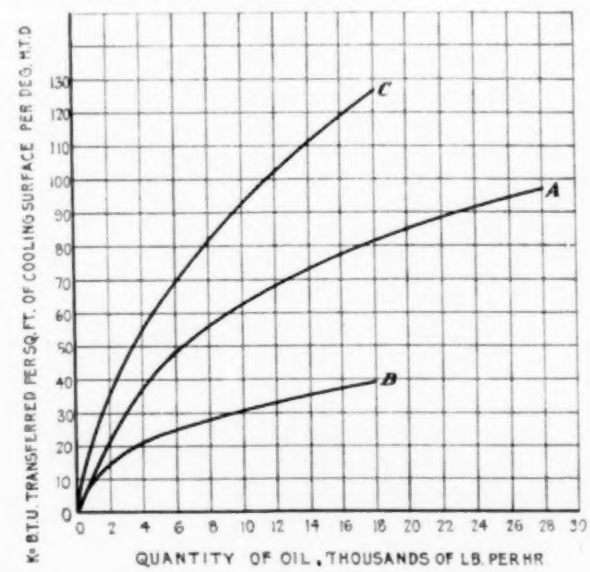


Fig. 5 Heat-Transfer Coefficients of Three Coolers

The writer discusses next the problem of determining both inlet and outlet oil temperatures. The further use of the temperature diagram is in showing the effect of the placing of two or more coolers in series, or the effect of tube length.

The temperature diagram deals, however, only with variable temperatures, and gives no information regarding the effect of various rates of flow of oil or water. Hence, a second division of a test of an oil cooler becomes necessary with the temperatures of inlet oil and inlet water constant and rates of flow of oil and water variable. The results of such a group of runs are plotted in Fig. 3 and constitute what is termed a "quantity diagram." The curves of Fig. 3 are cross-plotted in Fig. 4, to coördinates of water quantity and outlet oil temperature with curves of equal oil quantities. The two figures taken together show the complete relation between oil temperature flow and rates of flow of oil and water.

The quantity diagram provides a basis for determining the capacity of an oil cooler and rating it. But to say that a cooler has a certain capacity and not state definitely the conditions under which this capacity is produced is very unsatisfactory. The rating of a cooler may be defined as that quantity of a particular kind of oil which will be given the desired temperature drop with certain inlet oil and inlet water temperature and a certain quantity of water, or a certain ratio of water to oil used.

This theoretical discussion is followed by data and discussion of the actual performance of three types of coolers so selected that their performances should be comparable. Cooler *A* is of plain tubes; cooler *B* of plain tubes fitted with retarders; and cooler *C* of special corrugated concentric tubes, with dissimilar oil and water arrangements. The writer considers the heat-transfer coefficient as a measure of the surface effi-

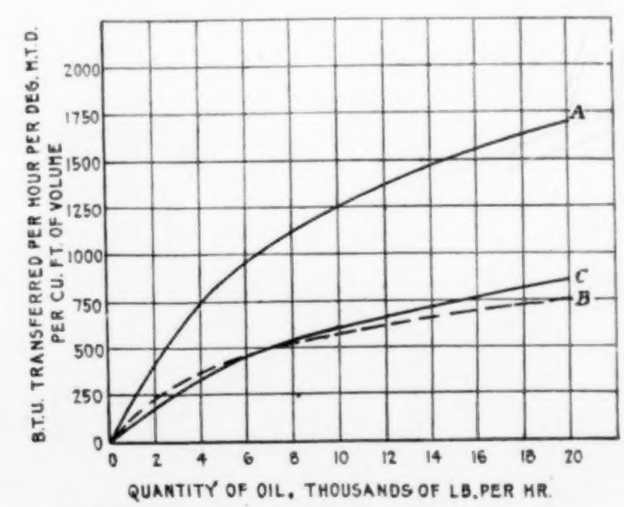


Fig. 6 Volume Efficiencies of Three Coolers

ciency of the cooler, but points out that the efficiency of the volume of the cooler is far more important than surface efficiency. A factor which places performance on a basis of volume of apparatus is B.t.u. transferred per hour, per degree mean temperature difference, per cubic foot of volume. From this point of view it is of interest to compare Fig. 5, which gives the heat-transfer coefficients, with Fig. 6, giving the volume efficiencies of the same three coolers. Of particular interest is the relative position of the curves *B* and *C* to each other in the two figures.

Finally the friction drop in the oil is considered, and it is found among other things that the relative friction drops are in the same order as the relative heat-transfer factors. In this connection it is also noted that weights per square foot of surface are in the order of the heat-transfer factors.

Summing up the subject of relative performance and merit of various types of coolers, the writer states that that cooler is best which will produce a given temperature drop in a given quantity of oil with the least volume and weight and without excessive friction drop. (*Journal of the American Society of Naval Engineers*, vol. 29, no. 2, May 1917, pp. 300-318, 10 figs., *teA*)

Navy Lubricants and Lubrication, Lieut.-Commander H. T. Winston, U. S. N.

The writer discusses the selection, testing and purchasing of lubricating oils for the Navy Department for various uses, such as lubricating oils for machinery, lubricants for cutting tools, greases, graphites, etc., and in an appendix gives the Navy specifications and tests for these materials.

Among other things the writer states that oils containing only 8 or 10 per cent of blown rape-seed, or other fixed oil, are not very satisfactory, especially at high speeds. The reasons for this are not entirely clear and the personal equation may be an important factor. Such oils do not form a heavy lather and seem to run off bearing surfaces easily, allowing the bearing to heat up. Possibly the mineral-oil contents used in these oils have too low viscosities and do not contain the emulsified constituents needed for sticking to the surface of the bearing. These oils also feed more rapidly than the heavier oils, unless the wicks are reduced in number, or the feed otherwise cut down. Hence, a man familiar only with the heavy oil is likely to let the oil box empty rapidly and the bearing run dry.

Straight mineral oils which form an emulsion with water and are exclusively a home product have been used with very good results in lieu of the compounded oil. This is shown by extensive tests on the torpedo boat *Bailey* at Annapolis, the battleship *Nebraska*, and other vessels. While the straight oil does not give a heavy lather, the bearings do not heat up; in fact, the machinery is cleaner and neater without a heavy lather.

The writer goes fully into the matter of classification of oils and the discussion of physical properties of straight mineral oils. As to the latter, he states that the important lubricating properties are viscosity, cold (or pour) point, emulsibility with water (cold or hot), and carbon actually deposited in an internal-combustion engine. Unimportant properties are carbon passing through the engine, gravity, fire point, flash point and frictional resistance.

Mixing similar *good* oils does no harm, and the resultant product shows no unexpected or abnormal properties.

As regards the so-called "worn-out" oils, the writer states that there is little evidence to show that a good oil wears out or loses any essential lubricating properties under ordinary circumstances. High heat will cause some light oils to become heavier, due to the distillation of a percentage of the original product, but the result is then simply a somewhat reduced amount of good oil with the increased viscosity. Interesting tests have been made on "used" lubricating oils, and a full description of such tests is expected to appear in the *Journal of the American Society of Naval Engineers*. Good oils used in forced-feed lubrication systems showed after about 1000 hours' use some oxidation, but the lubricating properties were not materially changed. The cold points were raised 10 to 20 deg. fahr. and there was an increase in the formation of organic acids and of resins. However, such harmful ingredients are easily removed by filtering the oil through animal charcoal, the filtered product being as good as, or, possibly better than, the original oil. (*The Journal of the American Society of Naval Engineers*, vol. 29, no. 2, pp. 239-261, *gd*)

Machine Shop

Calculating the Approach of Milling Cutters, Francis J. G. Rueter

The distance between the initial and final point of contact with the work, considering the point on the periphery of the cutter, is called the approach. This distance is used in time-study estimating together with the length of the piece or cut to determine the time required by the machine to do the work. The result is called the machine time.

To calculate the approach by the ordinary mathematical method requires too much time. The writer has therefore deduced a simpler formula from which the approach can be calculated by means of a chart in the original article. The solution is also easily made with logarithmic cross-section paper and by a slide rule. (*American Machinist*, vol. 46, no. 22, May 31, 1917, pp. 928-930, 7 figs., *p*)

Measuring Apparatus

A New Form of Pitot Tube, A. Hagenbach and K. Gégauff

Describes an exploration of the space surrounding a circular plate in a stream of air, the direction of the stream lines and the velocity and static pressure of the air being found by means of a new form of gage. This consists of a small tube of 1.6 mm. outside and 1 mm. inside diameter, closed at one end and pierced at the side with a small hole. The open end of the tube is connected with a pressure gage by means of an india-rubber tube. The closed tube is several centimeters long and is placed with the portion containing the opening at the point to be studied, the axis of the tube being perpendicular to the direction of the air stream. The tube is then rotated until the maximum pressure excess is obtained. This, by means of a pointer attached to the tube, gives the angle of the stream line. The tube is then rotated through 44 deg., first on one side of this direction and then on the other. The mean pressure at these points is the static air pressure, for it has been found by preliminary experiments that, for all air velocities, the null pressure is shown at an angle of 44 deg. (for the particular tube employed) from the direction of flow, while at 85 deg. the points of minimum (reduced) pressure are found. The results obtained in the case of air flowing at an average speed of about 6.5 m. per sec. past a normal circular plate are tabulated in full in the paper, and a map of isobars and stream lines is also given. (*Physikalische Zeitschrift*, vol. 18, pp. 21-30, January 15, 1917, through *Science Abstracts, Section A—Physics*, vol. 20, pt. 4, pp. 124-125)

THE USE OF OSCILLOGRAPHS FOR THE STUDY OF EXPLOSION ENGINES, M. Camillerapp

The writer indicates a method of investigating the part played by heat and the behavior of the spark in an explosion engine by means of the Blondel oscillograph.

In the course of a series of experiments made for the purpose of determining the part played by heat and the duration of the spark of the plug in the operation of an explosion motor, it proved to be impossible to use a manograph, because it was necessary to register simultaneously: *a*, the variations of pressure in the cylinder; *b*, the time between two explosions in the same cylinder with the view to determining the speed of the engine; and *c*, the current in the spark and its duration.

Curve 1 of the oscillograms in Figs. 7 and 8 represents the vibrations of a Lancelot electro- diapason giving 200 double vibrations; this gives the velocity of the photographic film of the decoiler of the oscillograph. This curve also gives the speed of the motor. To do this the current of the diapason passes through a rotary contactor located at the end of the motor shaft. This contactor short-circuits at each revolution with a resistance placed in series with the carrying circuit of the oscillograph. Hence each revolution of the engine is indicated by a fall in the amplitude of the curve of the diapason and the speed of the engine is measured by the oscillations registered between each revolution. The tests were carried out by a special laboratory-type oscillograph, and as quantitative results were not sought and it was only desired to obtain curves that would give an idea of the manner in which the ignition of the gas occurs, a special microphonic apparatus was employed.

Curve 2 shows pressures in the cylinder of the engine. It was obtained by means of a microphone held on the spark-plug frame in a manner illustrated in the original article.

Curve 3 gives the ignition current of the spark plug. A calibration of the oscillograph permits the determination of its volume in milliamperes; the return of the curve to 0 gives the duration of the arc between the terminals.

While the author makes no attempt to present the results obtained in his investigation, he indicates that, contrary to the view held by many engineers, ignition is not followed by a sudden explosion and the spark is not extinguished by the explosion, which he explains by the fact that after all no explosion occurs in the cylinder of the engine in the proper sense of this term; i. e., no sudden increase in the volume of the mixture. (Application de l'oscillographe à l'étude des moteurs à explosion, M. Camillerapp, *Revue Générale de l'Electricité*, vol. 1, no. 17, pp. 643-4, 4 figs. *e*)

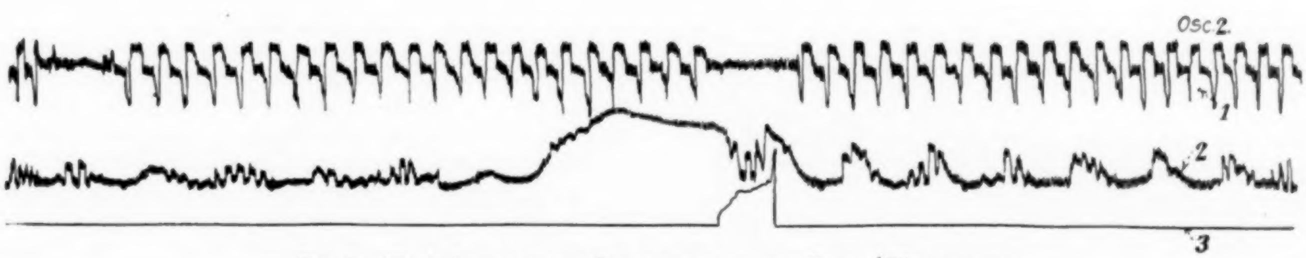


FIG. 7 (TOP) OSCILLOGRAM OBTAINED WITH THE SINGLE MICROPHONE

FIG. 8 (BOTTOM) OSCILLOGRAM OBTAINED WITH THE DOUBLE MICROPHONE

INTEGRATING TACHOMETERS, Commander L. A. Kaiser, U. S. N.

Description of an integrating speed indicator for use on board ships so designed as to make possible for the engine room to gain or lose distance as directed from the bridge. The bridge determines by stadimeter or otherwise that the ship is ahead or astern of position and directs the engine room to lose or gain. By consulting the previously prepared table kept near the throttle, the man on watch sets the engine hand ahead or in the rear of the clock, and then by the throttle causes the engine hand to lose or gain until it is in coincidence. If the variable gearing in the indicator is so designed that the engine hand makes one revolution per minute when the engine is making the prescribed speed, then it is evident that it is simply necessary to keep the engine hand coincident with the second hand of the clock, which also makes one revolution per minute.

With this in view, a device was constructed on board the *Washington* and installed by the ship's force under the direction of the present writer. It has been in use for nearly a year. This device consists essentially of a 12-in. flat disk of steel, driven by a 4-in. wheel perpendicular to its face and which is driven by a shaft connected by small gear wheels to the starboard revolution indicator. The distance of the driving wheel from the center of the large disk can be varied by a screw of ½-in. pitch. On this screw is placed a scale of revolutions. A clock of 14-in. dial, with a lone second hand, is placed over the center of the large disk, the latter carrying a U, over the ends of which an elastic band is stretched across the face of the clock. When the revolutions of the main en-

gines agree with the pointer on the scale, the disk should make one revolution per minute, the U-pointer exactly following the clock hand, and, conversely, by moving the scale indicator until the U-pointer exactly follows the clock hand, the number of revolutions of the main engine can be read from the scale.

An instrument was built from *Washington* blueprints and installed on the *Connecticut* during the battleship cruise around the world. The fleet engineer reported that the cruise has demonstrated the necessity for some instrument which will show the exact speed of revolutions of the engines at any time. Such an instrument would make it possible for the engines to be run at constant speed, and in changes of speed enable the man at the throttle to take up new speed with practically no loss of time in counting revolutions as at present.

The character of the traction surfaces, that is, the surface of the disk and the rim of the driving wheel, has an important bearing on the correct functioning of this instrument. It has been found by experience that best results are obtained by making the disk of a saw-steel blank and making the rim of the driving wheel of small radius and of hardened steel. In pouring a stream of oil over the point of contact and also in coating the face of the disk with lard, no slip was discovered. (*Journal of the American Society of Naval Engineers*, vol. 29, no. 2, May 1917, pp. 262-267, 1 fig., *d*)

Mechanics

The Laws of Elastico-Viscous Flow, Prof. A. A. Michelson

When a solid is subjected to a strain beyond the elastic limit, its behavior may be summarized as follows:

1 The application of the stress results in a rapid elastic yield which, if inertia be negligible, is practically instantaneous. If the stress be now removed, the specimen returns to its former position.

2 This is followed by a slower yielding, whose rate, if the stress is not too great, diminishes with time, and which ultimately attains a constant value which may be zero. The return to or near its original position depends on whether the stress was or was not too great.

The writer makes an attempt to formulate the behavior of substances under stress by the simplest expressions which have been found to satisfy all the essential requirements, and states that the behavior of any solid under stress may be considered as the resultant of four elements constituting the Laws of Elastico-Viscous Flow.

The *elastic displacement* is characterized by being approximately proportional to the stress and independent of time. A closer approximation is given by

$$S_1 = C_1 P e^{L}$$

in which $L = h_1 P$

The *elastico-viscous displacement* is manifested in a slow return when the stress is removed. This displacement is represented by the formula

$$S_2 = A_2(1 - e^{M})$$

where $A_2 = C_2\ Pe^{N}$, in which $N = h_2\ P$, and $M = -\alpha\sqrt{t}$.

The *viscous displacement* applies to the case where the elastic force is absent or very small in comparison with the viscous resistance. For a specimen which has not been subjected to previous strain, the formula is

$$S_3 = (Ft)^{\rho}$$

where $\rho = \frac{1}{2}$ approximately; near the rupture point ρ approaches unity.

A more complicated formula is given for the general case.

The *lost motion* is explained as follows: If the stress be applied for a short time (even a small fraction of a second), the specimen does not return to the original zero. The difference between the original and the new zero is the lost motion. It seems probable that lost motion may be considered as a function of time.

The following notation is used in the above formulæ:

S = displacement (twist)
t = time
$F = C_3\ Pe^{N}$, where $N = h_3\ P$
h, α, constants
P = applied torque.

(*Proceedings of the National Academy of Sciences of the United States of America*, vol. 3, no. 5, May 1917, pp. 319-323, *t*)

Railroad Engineering

Recent Attainments in Locomotive Feedwater Heating

Supplement to the preceding report which covers the subject mainly from the theoretical standpoint, while the present article shows to what extent the savings from feedwater heating have been actually attained through means entirely consistent with American locomotive practice.

These experiments were made with the heater deriving its heat supply from exhaust steam and resembling in its construction a well-known surface condenser. The heat-exchanging elements were $\frac{5}{8}$-in. (outside diameter) brass tubes of such number and length as to give a total heating surface of about 120 sq. ft. As the heat transfer is facilitated by the agitation of the water in its passage through the tubes, this result was accomplished in this case by inserting in each a strip of brass of a width equal to the inside diameter of the tube slightly crimped and twisted to a pitch of $3\frac{1}{2}$ in.

While the proportions of the heater were such, and the agitation of the water so thorough as to yield final temperatures within 10 or 15 deg. of the temperature of the exhaust steam, no undue burden was placed on the feedwater pump. The extent of the dropping pressure in the heater was roughly 1 lb. for each 2000 lb. of water delivered per hour. The average initial temperature of the feedwater over a given series of tests was 50.7 deg. In this same series the average temperature of the water delivered to the boiler was 214.5 deg., indicating the average increase as between the inlet and the outlet sides of the heater of 163.8 deg. The proportions of the heater must have been pretty nearly correct for the conditions of test to permit of a very close approximation to the temperature of the steam.

The effect on the quantity of coal consumed was very marked. On the indicated hp.-per-hour basis, the quantity of coal saved was in no case less than 12.9 per cent, this value in one instance being as high as 28.1 per cent.

On the basis of thermal efficiency of the locomotive, the average increase (disregarding the results in three out of ten tests) was 20.3 per cent, and the highest of these values was only 4 lb. in excess of the average, showing consistency in the results.

Since the average increase in the temperature of feedwater was in excess of 160 deg., the theoretical deduction of 1 per cent increase in efficiency attainable through each 10 deg. rising temperature, as indicated in the report of the Fuel Association Committee, is well within the bounds of conservatism.

The original article contains the diagram indicating the relation between water rate and heat expended in pumping and

recovered by feedwater heater. (*Railway Review*, vol. 60, no. 22, June 2, 1917, pp. 753-754, 1 fig., *e*)

Locomotive-Feedwater Heating

Data from a report by a committee, Monroe B. Lanier, Chairman, presented at the Convention of the International Railroad Fuel Association held in Chicago in May.

The economy expressed in the percentage of fuel saving to be derived from preheated as compared with non-preheated feedwater, is in direct ratio as the temperature difference of the water before and after heating is to the difference between the total heat of the saturated steam at a given pressure and the final temperature of preheated feedwater. With other conditions remaining equal, the higher the initial temperature the greater is the percentage of economy per degree rise of preheat. In fact, the writer gives a curve showing that the theoretical fuel saving from preheat follows a straight-line law.

From an operating standpoint feedwater heating is a prerequisite to the best performances and maximum locomotive efficiency. The utilization of preheat permits a freer steaming boiler, increases the confidence of the fireman and leads to an increase in locomotive capacity. An interesting series of curves is given showing the amount of money to be saved yearly by the railroads through feedwater heating.

As to the sources of preheat, the writer indicates that exhaust steam and waste gases may be used for this purpose. The greatest waste seems to be in exhaust gases, but most of it is unavoidable. The writer presents a calculation showing the content of latent heat in the gases and states that experiments have shown that the abstracting of 16 per cent of the exhaust does not, in most cases, require a reduction in the size of the nozzle to get the same vacuum in the front end and the same draft in the fire. A table is given in this connection covering the subject of distribution of heat in a normal locomotive, the same subject being also illustrated graphically.

The next source of heat for preheating water is that of the smokebox. It is impracticable to design an exhaust heater to preheat water from the tank-boiler temperature, but ample space is available in the front end of the modern locomotive, in addition to space required for superheater, units to build a gas heater of sufficient heating surface to obtain a high degree of preheat feeding by means of an injector, the preheat increasing with the velocity and temperature of the gases.

As the final temperature of the feedwater from the exhaust heater is limited to a point below that of the temperature of the exhaust steam, the smokebox heater presents greater possibilities when injector feeding is practiced, particularly with certain types of injectors.

The writer advocates the advisability of the combined use of exhaust steam and smokebox heating, as after utilizing in preheating all of the exhaust steam possible, there is still a margin of 140 to 180 deg. between the feed temperature and that of the water in the boiler. On the other hand, the practical limit of preheating feedwater by means of smokebox gases is that of the boiling point which at 200 lb. pressure is 388 deg. fahr. (*Railway Age Gazette*, vol. 62, no. 21, May 25, 1917, p. 1101-1105, 3 figs., *g*)

Refrigeration

Circulation in Flooded Systems, A. H. Baer

Data of experiments with the glass model of an ammonia-tank coil and an accumulator. By supplying these with liquid ammonia inside, and with ordinary hydrant water—also with ice water—on the outside, the behavior of the ammonia could be plainly observed.

The apparatus used for the test was similar to that shown in Fig. 9 and the experiments were made with the coil nearly filled with liquid ammonia; first, in the open air, then sprinkled with hydrant water, and finally with ice water on the outside. In general, the direction of flow was, of course, upward and out from the upper part of the accumulator. The observers were surprised to see that the gas in the lowest horizontal pipe flowed backward and up through the bottom of the accumulator. Further, the vapor in the second lowest pipe cast out through the bottom pipe and up through the drain pipe of the accumulator. And in doing so it pushed ahead of it a large part of the liquid in the lower pipe, delivering it to the accumulator and raising its liquid level.

The apparatus was then somewhat reconstructed and a greater head of liquid was provided, but this failed to keep the gas in the lower pipes from flowing backward and up through the bottom of the accumulator.

The glass model was then again checked and a check valve

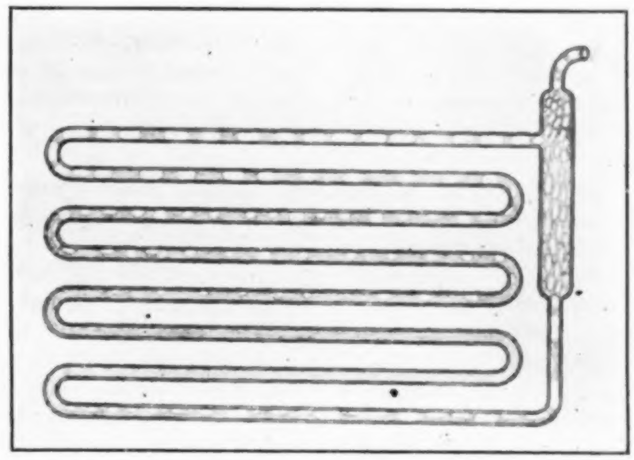


Fig. 9 Glass Model of a Tank Coil and an Accumulator Used for the Study of Circulation of Ammonia in Flooded Systems

was placed in the drain pipe from the accumulator. When this model was partly filled with liquid ammonia and the water applied as before the evaporation of the ammonia was uniform throughout the length of the coil and all gas flowed from the lower pipes up through the entire coil. The gas formed into bubbles which drove ahead of them the liquid, and as the bubbles approach the upper pipe and the outlet of the coils they become larger and the liquid bodies between them become smaller by reason of continual evaporation of some of the liquid while passing through the coils. At the inlet to the accumulator the small amount of liquid remaining between the gas bubbles readily flowed into the accumulator and the vapor only passed from the outlet at the top. The check valve was found to lift when the accumulator became partly filled with return liquid.

The apparatus diagramatically shown in the original was then applied to the ice tank with a check valve especially designed for this purpose. The ammonia feed to the system was purposely arranged to favor lifting of the check valve. Repeated trials showed that the check valve regularly lifted whenever the level of the liquid in the accumulator was raised. Since this variation in level cannot be very great, the check

valve must operate frequently. It has been found that a distance of from 3 to 4 ft. between the top pipe of the coils and the bottom of the accumulator is sufficient to provide the necessary liquid head for operating this valve positively and regularly without causing the liquid to fill up more than a few inches in the bottom of the accumulator itself.

This apparatus gave good results and it was thought that the efficiency of an ice plant could be further increased by flooding also the water fore-cooler coils. Actually, however, the results were not so gratifying as in the case of the ice tank.

In addition to this the writer describes the present direct flooded system and the so-called submerged flooding system, and discusses the questions of comparative efficiency of plants. (*A. S. R. E. Journal*, vol. 3, no. 6, May 1917, pp. 5-15, 5 figs., *eA*)

Ammonia-and-Water Mixer, H. Dannenbaum

Data on the so-called ammonia-and-water mixer specified in the municipal regulations of the City of New York, obtained from experiments made at the factory of the National Ammonia Company, Philadelphia, Pa.

The regulations provide that the refrigerating plants must be equipped with emergency pipes by which, in case of accident, the ammonia can be discharged into water or brought into contact with sufficient water to absorb all the ammonia gas.

The apparatus is constructed so that the ammonia gas can be absorbed by running water, which makes it comparatively simple and inexpensive.

The article describes the apparatus used and the experiments carried out. These experiments have shown that there is a definite minimum amount of water necessary for the successful operation of the mixer, and that when less than this amount passes through, the mixing may cease and ammonia gas enter the sewer. On the other hand, the experiments show that the mixer of the type described properly proportioned will give satisfactory results. A suggestion has recently been made to connect the ammonia mixer to the bottom of the liquid receiver. This would mean that liquid ammonia would be blown into the mixer, but, of course, in considerably larger quantities than the gas. Some experiments have also been made with such an arrangement. (*A. S. R. E. Journal*, vol. 3, no 6, May 1917, pp. 16-19, 1 fig., *d*)

Steam Engineering

Recent Installations of Large Turbo-Generators, Richard H. Rice

In this paper the history of the development of the General Electric turbo-generator units is first briefly reviewed, beginning with the 5000-kw. vertical machine installed in the station of the Commonwealth Edison Company at Chicago in the year 1903, and leading up to 45,000-kw. units in a single shell now under construction. Without such far-sighted treatment of the situation as has been given by central-station owners, the development of the steam turbine with the rapidity which has characterized it would not have been possible.

A curve is given showing that the steam consumption in 1916 was exactly half of that in 1903. Another curve shows that the price per kw. in 1917 is 42 per cent of that in 1903, and the weight per kw. in 1917 is about 28 per cent of that in 1903. The initial steam pressure has increased from 175 lb. to 300 lb., and the initial temperature from 378 deg. to 660 deg. The vacuum used has also increased from about 27 in. to about 29 in.

Great progress has also been made in boiler-house efficiency. Economizers are being used, and feedwater heaters in the flues are also possible. With the most modern conditions, a boiler-house efficiency of 81 per cent can be obtained with blast-furnace gas.

As a result of all of these improvements, the heat consumption of a complete electric station in B.t.u. per kw-hr. has decreased until it is now about half of the value of 1903. Fig. 10, reproduced herewith, shows the curve.

Estimates are given—using information from plants in actual operation—of first cost and operating cost of complete blast-furnace and steel-mill plants using respectively gas engines and steam turbines. The plant chosen is one of four blast furnaces, each capable of producing 550 long tons of pig in 24 hours with a coke consumption of 1800 lb. of coke per long ton of pig. The necessary electric generating apparatus for a steel mill has been provided, of suitable capacity to utilize all of the available gas in the case of the gas-engine plant, and to furnish exactly the same amount of power to steel mills in the case of the steam-turbine plant. Some make-

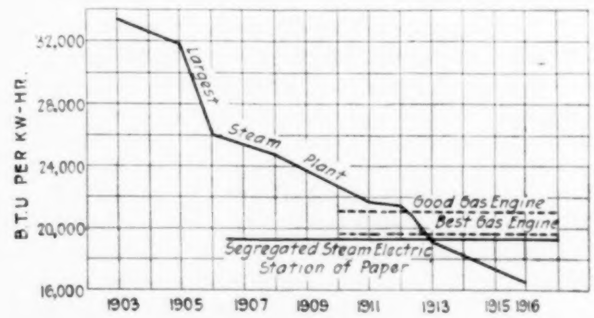


Fig. 10 Heat Consumption in B.t.u. Per Kw-Hr. for Complete Electric Stations on Steady Load (The Figures in All Cases Cover All Power-Plant Apparatus, Including Auxiliaries and Emergency Reserves)

up coal is required in the gas-engine plant on account of occasional deficiency of gas supply or excessive mill load.

The boilers of the turbine plant have considerable heat-storage capacity and probably would require no make-up coal. However, for conservatism, this is ignored and a small additional amount of coal needed to make the heat balance the same in turbine plant as in gas-engine plant is included in the costs.

A complete outfit of power-plant auxiliaries is included, with such reserve for emergency spares as has been found necessary in practice in the case of gas-engine plants. This calls for steam spares and reserve boilers, capable of being fired by blast-furnace gas or coal in emergencies. Pumping stations are included to supply the demands of the gas washing and electric stations, the blast furnace, and a given amount of water to the steel mills.

This portion of the paper abstracts a previous paper before the Engineers' Society of Western Pennsylvania, March 1917, reviewed in the Engineering Survey, May 1917, p. 461, except that in the present case the boiler plant has been improved by use of modern arrangements previously discussed so as to yield an efficiency of 81 per cent.

In the present case, that part of the plant comprising the electric station is also segregated and independent figures

given. This segregated electric station includes the electric power house, together with that fraction of all parts of the plant directly appertaining to the electric power house, such as boiler house, pumping and gas-washing station, etc. The items necessary to constitute a complete practical modern plant have been included.

Abstracts of the figures and specifications of the plant are given in the appendices to the paper. All costs are based on prices ruling in November 1916.

The overall B.t.u. consumptions of the segregated electric stations of the plants, including all the auxiliaries and emergency reserves, are given in horizontal lines in Fig. 10. The total charges for operation of the plants, including fixed charges, are shown in Fig. 11, first for the complete plant, and second for the segregated electric station.

It will be noted that the turbine plant is very much cheaper than the gas-engine plant, so that the resulting fixed charges taken at 13 per cent are very much less. It will also be noted that the running charges of the cheaper plant are also much the lower. Hence the total charges of the turbine plant are very much lower than the total charges of the gas-engine plant. In other words, the modern steam turbine has reached such a state of development that the modern gas engine is not a competitor.

Utilization of heat units is only one of the secondary operations with which the management of blast furnaces and steel mills is concerned. However, the saving which could be made over existing practice is so large that the author suggests the creation of a separate department of the works to handle the question of power generation, under the control of an engineer of necessary attainments and experience, so that results equal to those obtained by central power stations can be realized for blast-furnace and steel-mill installations.

The utilization of waste heat from open-hearth and heating furnaces (and even from Bessemer converters), the use of by-product gas resulting from the manufacture of coke, and the installation of modern steam-turbine plants at all furnaces, capable of utilizing to the maximum extent possible the heat from the individual furnaces and mills; and the tying together of all plants in a closely developed place like Pittsburgh by electric cables will probably render it unnecessary to develop any power in such a district by the use of raw fuel. (Paper read before the *American Iron and Steel Institute* at New York, May 25, 1917, *hgc*)

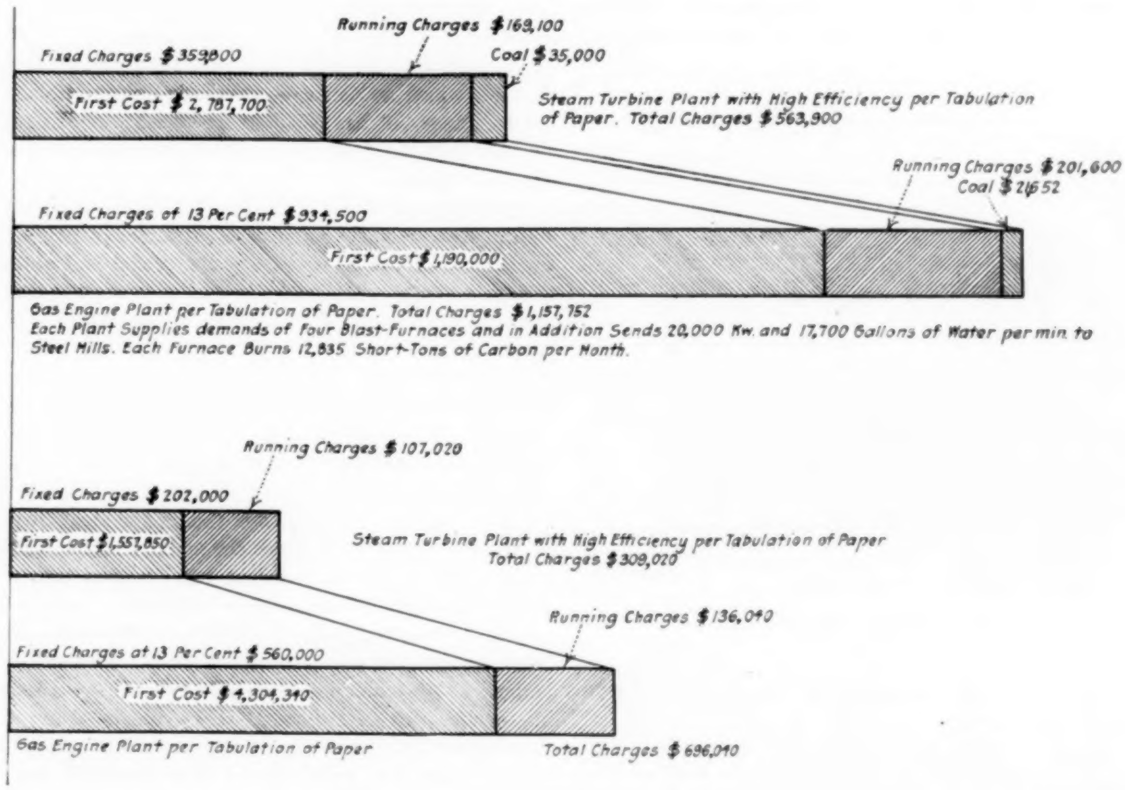


FIG. 11 CHART OF COMPARATIVE CHARGES FOR FOUR FURNACE PLANTS. (THE TOTAL LENGTHS IN EACH CASE GIVE TOTAL COSTS OF EVERY KIND, INCLUDING FIXED CHARGES, REPAIRS, MAINTENANCE AND OPERATION AND MAKE-UP COAL. ALL FIGURES ARE DOLLARS PER YEAR)

THE QUESTION OF THE TAPERING OF THE NOZZLES OF STEAM TURBINES, H. Baer

Deals with the flow conditions in actually constructed turbine nozzles. It was found previously that non-tapered nozzles can advantageously be used for pressure drops far above the critical drop, up to which latter value they are theoretically usable; and the experiments described in the present paper confirm this view. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 60, pp. 646-650, 669-676, August 5 and 12, 1916, through *Science Abstracts, Section B—Electrical Engineering*, vol. 20, pt. 4, p. 121)

THERMO-PLUG STEAM BOILERS, Enoch Rector

The thermo-plug steam boiler, Fig. 12, consists preferably of a low cylindrical drum *A*, which in its turn consists of two

flanged heads welded together by the oxy-acetylene process. The heads are properly stayed and the bottom head is drilled and tapped to receive the thermo-plugs, Fig. 13, which have a tapering thread. The plug holes should be as close together as possible, depending on the thickness of the metal and the diameter of the plugs.

The drum is supported by brackets, and the hole enclosed in a spiral coil of pipe *L* wound close and packed together by the oxy-acetylene welding process to form a complete and very rigid outer shell for the boiler. The feedwater is forced through this coil before entering the economizing coil at the top *B*, thereby maintaining the lowest possible temperature on the outside. The economizing coil is suported above the drum into which it discharges, and the flue gases after pass-

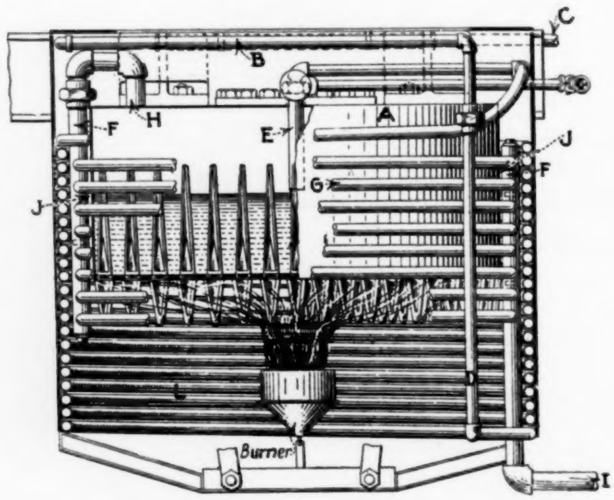


Fig. 12 Thermo-Plug Steam Boiler

ing between the drum and the encasing coil *J* pass between the coils of the economizer.

These boilers have been developed in sizes from 10 to 100 hp. The drums are all 12 in. in height, the diameters ranging from 12 in. to 36 in. The 100-hp. unit consisting of a drum 12 in. high and 36 in. in diameter contains 306 thermo-plugs. It is enclosed in a spiral coil containing 420 ft. of 1-in. pipe and an economizing coil containing 463 ft. of 1¼-inch. pipe. As high as 200 deg. of superheat can be obtained when the

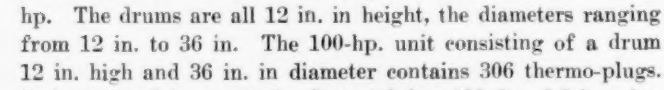


Fig. 13 Thermo-Plug

boiler is forced. The maximum capacity of the boiler is aproximately 420 lb. of water per hour from and at 212 deg. fahr., with an evaporation of 14 lb. of water per lb. of oil. The overall dimensions of the boiler are 4 ft. in diameter by 6 ft. in height, and the approximate weight is 4500 lb.

The external projections of the thermo-plug units should extend into the heated gases with a decreasing section and be so designed as to permit the gases to escape readily. The ends of the plugs projecting outward are made sufficiently long to increase the rate of resistance to heat conduction, so that the ends become incandescent.

In an experimental test in which one burner was used the thermo-plugs in the center became incandescent, while the plugs farthest removed did not show any sign of color. The temperature of the gases 1 ft. above the outer row of thermo-plugs and in passage *J* was 590 deg. fahr. The evaporation was 92 lb. of water per sq. ft. of crown shed.

The internal projections of the thermo-plugs should be long enough to always extend above the water level. They should have a radiating or wetted surface not less than two-thirds of the external heating surface and they should be tapered to a point with surfaces which permit the ascending steam to escape with the least possible resistance, giving the highest possible velocity. The steam escaping rapidly along these plugs not only assists in keeping the surfaces clean but also drags the water along with it, creating a very violent circulation.

High-silicon cast iron has been found to be the best material of which to make these thermo-plugs, because, among other things, it has a lower coefficient of expansion than the steel of the drum, a condition favorable in this instance to a continuously tight screwed joint.

The writer states that after 3½ years of experimenting with a boiler which has suffered all kinds of abuse, been permitted to run dry a great many times, and had water pumped into it while hot, the boiler is still in perfect working condition and has never sprung a leak. These experiments have all been confined to Newark, N. J., where the water is fairly good.

In the discussion which followed the writer stated that the principle on which the use of the thermo-plugs is based, is the same as that of a target of firebrick in a large oil-fired boiler; the plugs are put in to get high-temperature target surfaces, but at the same time this is the most direct method of transmitting heat through the metal into the water.

In a number of tests water was pumped into this boiler while it was hot. This would be dangerous to do, if the water, in the form of water, could get to a red-hot surface; but with this construction it is impossible to get cold water into the boiler. If the boiler is properly heated there is a large amount of specific heat in the metal which the incoming water will take up while passing through the economizing coils to sufficiently evaporate a portion of it before reaching the main drum.

The boiler is operated at about 300 lb. pressure. Enough economizing coils are put on the top to bring the tenperature of the escaping gases down to 300 deg. fahr. (*A. S. R. E. Journal*, vol. 3, no. 6, May 1917, pp. 20-29, 4 figs., *d*)

The Evolution of the Steam Turbine in the Textile Industry, John A. Stevens, Mem.Am.Soc.M.E., and Associated Engineers

Discussion of the application of the steam turbine in the textile industry, with a brief summary of the history of the development of steam turbines generally. The writer discusses, among other things, the mutual positions of the steam turbine and the steam engine and presents the main reasons for the supremacy of the former, especially in larger sizes. Of particular interest is the following: In the words of the writer, perhaps the most important characteristic of the turbine is the fact that it can be built in almost unlimited sizes. A single unit of 70,000 kw. is now under consideration and larger units contemplated. In this field engine-driven units above 5000 kw. are very uncommon. The largest reciprocating engine known is being installed at the Lukens Steel Company and is to develop 25,000 hp. The largest reciprocating marine engines are capable of developing 20,000 hp.

The paper discusses, among other things, low pressure, mixed pressure, and extraction turbines. The latter also called "bleeder" type, is perhaps one of the most important and convenient developments. It is probably due to the demands of the textile industry, more than any other, that this type of machine was developed. The steam extracted is absolutely free from oil and can be used with great economy without any danger to products in such processes as dyeing, bleaching, slashing, etc., in addition to drying and heating.

The matter of reduction gears is discussed in some detail. From this the writer proceeds to a discussion of the steam turbine on mechanical mill drive. The first application of the steam turbine on a mechanical mill drive of considerable size is said to have been made early in 1913 by the Parsons Company of England, and was a 700-hp. unit for driving a jute mill in Calcutta, India. The turbine was for low pressure, taking steam from old engines. The turbine and engines ran in parallel. The single-reduction gear gave a change of speed from 3000 to 300 revolutions per minute, and the drive from this low-speed shaft to the mill shafting was through ropes.

A considerable number of direct-drive turbines have recently been erected in this country. Of these the writer describes two which he has installed himself. One of these, at the Jackson mill of the Nashua Manufacturing Company, is for 16,800 hp. at 160 lb. steam pressure and with 28 in. of vacuum. It is claimed to be the largest anywhere in use to date. The unit consists of a DeLaval steam turbine with single reduction gear changing from 32,800 to 308 revolutions per minute. Two rope sheaves 64 in. in pitch diameter and each carrying twenty-four 1⅓-in. ropes connect to the two main mill head-shafts. The condenser is a Leblanc jet-type condenser located in the basement directly under the turbine exhaust nozzle.

The writer particularly emphasizes the improvement of economy in steam consumption with advance in the art brought about partly by refinements in design and partly by increase in size of the generating units. Two tables in the original article bring out this point very clearly. One of these tables gives efficiency and economy for steam engines driving generators and the other, the same for steam turbines and generators.

From these tables the writer derives the following conclusions: First, the steam engine in the smaller sizes is more economical in the use of heat than the steam turbine. Second, the economy of the steam turbine increases rapidly with increase in size of units. The economy of the latest type of turbine of about 1000-kw. size is practically equal to the best obtainable in the largest and most economical engine built. While the larger turbines are more economical in proportion, the limit of appreciable improvement in economy is reached at about the size of 30,000 kw. Third, the best thermal efficiency reached at the present stage of the art is 26.5 per cent. If, however, all exhaust be used, the thermal efficiency becomes very much higher.

Among other things, the paper describes a new large-size boiler unit designed to be employed in connection with the 50,000- and 60,000-kw. turbines now coming into use in this country. This boiler was developed by a manufacturing company with the assistance of Arthur D. Pratt, Mem.Am.Soc.-M.E., and embodies certain types of general design suggested by the writer. The unit is a complete structure in itself, embodying boilers, superheaters, forced- and induced-draft fan equipment, uptakes, stack, coal bunkers and ash hoppers, even economizers (Fig. 14). This unit is, in reality, made up of four independent sections more completely arranged than has been the usual custom. Any section of the unit may be independently operated while inspecting, cleaning or repairing is going on in the remaining sections. The approximate areas in this unit are as follows:

Grate area...........	936-1108 sq. ft.	(projected area)
Water-heating surface.	57,600 sq. ft.	
Superheating surface..	14,352 sq. ft.	
Economizer surface...	36,800 sq. ft.	(contemplated)
Total heating surface.	108,752 sq. ft.	

This unit, with one section down for repairs, would easily supply steam for a 30,000-kw. turbine and its auxiliaries, while the entire unit would deliver enough steam to operate a 45,000-kw. turbine. The writer has observed this general type of boiler operating for short periods of time at 400 per cent and over. Under these conditions the entire unit would supply steam enough for a modern 58,000-kw. turbine using high-pressure steam and high superheat.

The unit as shown contains approximately 10.75 miles of 4-in. tubes in the water-heating surface alone. The total length of the 2-in. superheater tubes in one unit as shown is approximately 5.19 miles. The total length of the economizer tubes as now contemplated for one unit is 10.64 miles, or in all, 26.58 miles of tubes per unit. (Paper read before the *National Association of Cotton Manufacturers* at a meeting held in Boston, Mass., April 25, 1917, 39 pages, 22 figs., *hgdA*)

Thermodynamics

Gas Calorimeter Tables[1]

The numerous requests for a brief and concise set of operating directions for a gas calorimeter, and for a convenient set of correction tables, has resulted in the publication by the Bureau of Standards of Circular No. 65, Gas Calorimeter Tables. This may be regarded as a supplement to Bureau Circular No. 48, Standard Methods of Gas Testing. The correction tables are arranged in a sequence most convenient for use in connection with the proposed record sheet.

The record forms for calorimeter tests which are shown in the circular have been used for some time and found to be complete and convenient. It is hoped that these forms will be adopted wherever possible so that there will be greater uniformity in operating methods and the records used. The Bureau is willing to loan the original plates for preparation of electrotypes for these blanks to any one desiring to print them.

The Calculation of the Constants of Planck's Radiation Equation, an Extension of the Theory of Least Squares,[2] Harry M. Reeser

The problem of computing from experimental data the constants, c_1 and c_2, of Planck's radiation equation for the distribution of energy in the spectrum of a black body is attacked by the method of least squares. The data were furnished by Dr. W. W. Coblentz and have been used to determine the constant c_2 by another method. (Bull. Bur. of Stds., *13*, 1916, p. 474).

The observation equations were reduced by taking logarithms of both sides and assigning proper weights to the equations so transformed. The method of assigning weights is given in a general form that can be adapted to any scheme of transformation.

It is shown that the "two-point" method, (Bull. Bur. of

[1] Abstract of Circular No. 65.

[2] Abstract of Scientific Paper No. 204.

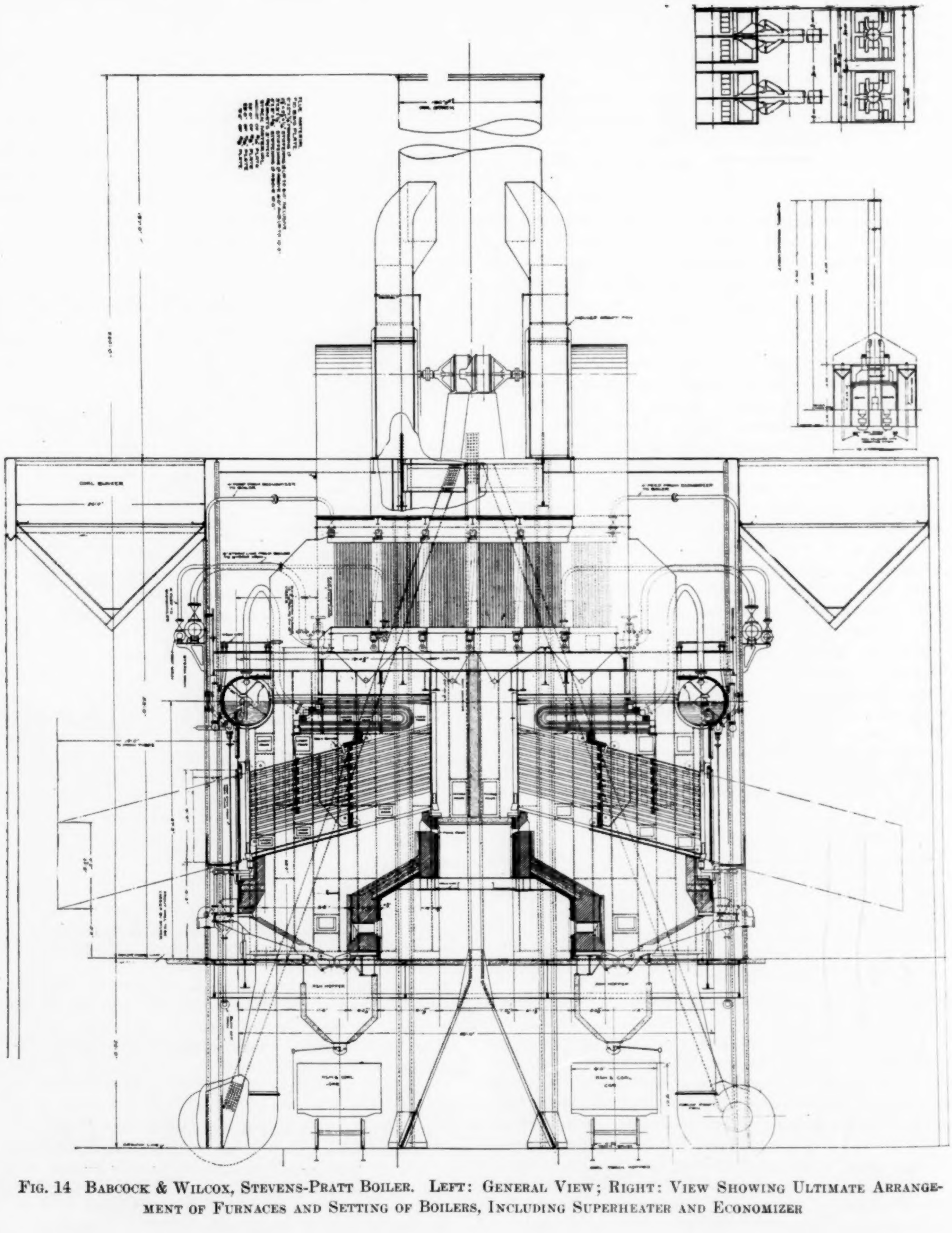


FIG. 14 BABCOCK & WILCOX, STEVENS-PRATT BOILER. LEFT: GENERAL VIEW; RIGHT: VIEW SHOWING ULTIMATE ARRANGEMENT OF FURNACES AND SETTING OF BOILERS, INCLUDING SUPERHEATER AND ECONOMIZER

Stds., *13*, 1916, p. 535) of determining c_e may be made identical with the least-square solution, if all possible pairs of points are combined and a proper system of weights is applied to the separately computed values before taking the mean. This is suggested by T. W. Wright, in Adjustment of Observations, 1884, p. 141. A short numerical example is given to show that this system of weights being applied to an arbitrarily selected number of computed values, the weighted mean approximates the least-square value better than the simple mean.

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Some Meteorological Conditions Which Increase the Danger of Flying, Capt. C. J. P. Cave. Aeronautics, vol. 12, no. 186 (New Series), May 9, 1917, pp. 338-340, 12 figs.

AIR ENGINEERING

High Pressure Air Compressor Design and Application, Joseph M. Ford. Canadian Machinery and Manufacturing News, vol. 17, no. 22, May 31, 1917, pp. 560-564, 10 figs.

Graphic Solutions of Some Compressed-Air Calculations, C. W. Crispell. Bulletin of the American Institute of Mining Engineers, no. 126, June, 1917, pp. 969-977.

CONVENTIONS

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The Embrittling Action of Sodium Hydroxide on Soft Steel, S. W. Parr. University of Illinois Bulletin no. 94, vol. 14, no. 18, January 1, 1917, 17 figs. 12 tables.

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The Foundry Behind the Automobile, The Iron Trade Review, vol. 60, no. 21, May 24, 1917, pp. 1131-1139, 15 figs.

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† Abstracted in the Engineering Survey in this issue.

HEAT TREATMENT AND FORGING OF STEEL

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The Use and Abuse of Steel, Lieut.-Colonel R. K. Bagnall-Wild and Lieut. E. W. Lirch. The Automobile Engineer, vol. 7, no. 102, May, 1917, pp. 120-128, 37 figs.

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Relative Methods of Forming Steel by Pressing, Hammering or Rolling, John Lyman Cox. The Blast Furnace and Steel Plant, vol. 5, no. 6, June 1917, pp. 252-257, 8 figs.

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- No. 2 Boulons Normaux d'Assemblage (Dimensions des Totes et Filetage) Acier.
- No. 3 Ecrous Normaux (Numerotation).
- No. 4 Ecrous Normaux (Dimensions).
- No. 5 Goujons Normaux d'Assemblage (Numerotation et Dimensions) Acier.
- No. 6 Vis Normales d'Assemblage (Numerotation) Acier.
- No. 7 Vis Normales d'Assemblage (Dimensions des Tetes et Filetage) Acier.

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CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society. The Editor will be pleased to receive inquiries for further information in connection with articles reported in the Survey.

Change in Government Boiler-Plate Specifications

As the results of protests of manufacturers of boiler plate that the requirements of the rules of the Board of Supervising Inspectors, United States Steamboat-Inspection Service, governing the manufacture of steel boiler plate are too stringent, and unnecessarily increase the cost of making boiler plate to meet regulations, the executive committee of the board has adopted amendments relaxing the requirements for physical qualities of steel plates and for the drilling of tube and stay holes.

Manufacturers claim that the requirements of the existing regulations add from 5 cents to 6 cents per lb. to the cost of steel boiler plate made to meet the rules of Lloyd's Bureau, without in any way increasing the serviceability of the boilers made therefrom. After examining the evidence in support of this claim, the executive committee has adopted the following rule for physical quality of steel plates:

> The tensile strength determined by the tests shall be not less than 58,000 lb. per sq. in. of section, nor more than 73,000 lb. per sq. in. of section, and the elongation measured in a gage length of 8 in. shall be not less than 20 per cent.

No change was made in the regulation regarding the physical properties of iron plates, the tensile strength of which must be not less than 45,000 lb. per sq. in., with an elongation of not less than 15 per cent. The reduction of area must be not less than 15 per cent for 45,000 lb. tensile strength, and for each increase of 1000 lb. up to 55,000 lb. an addition of 1 must be made to the required percentage of reduction of area.

The board further modified the regulations concerning tubes and stays by striking out of section 15, rule 2, the requirement that "all holes for tubes shall be drilled and no part punched," and out of section 16, rule 2, the stipulation that "all holes for stays shall be drilled and no part punched," substituting therefor the following:

> Centers of guide holes not to exceed 75 per cent of the diameter of the full-size finished hole for which tubes and stays may be punched. The remainder shall be cleanly cut, drilled or reamed to full size.

The amendments have been approved by the Secretary of Commerce and become effective immediately. (*The Iron Age*, vol. 99, no. 23, June 7, 1917, p. 1372)

On May 16 a contract was entered into for the boilers for the first of the ships of the new Emergency Fleet being built under the supervision of Major General Goethals.

The contract for these ships, eight in number, of 8800 tons dead-weight capacity, 426 ft. in length and 54 ft. beam, was recently awarded to the Los Angeles Ship Building and Dry Dock Company.

The equipment comprises four standard Heine marine boilers for each vessel, making thirty-two units in all. Each boiler is to contain 2900 sq. ft. of heating surface. The boilers will be oil-fired and built for 200 lb. working pressure.

In general, the design of these boilers is similar to those installed on the *Minnesota* and also now being installed on the ships of the Luckenbach Steamship Company, building at the Fore River Shipbuilding Company and the Sun Shipbuilding Company.

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PERSONALS

IN these columns are inserted items concerning members of the Society and their professional activities. Members are always interested in the doings of their fellow-members, and the Society welcomes notes from members and concerning members for insertion in this section. All communications of personal notes should be addressed to the Secretary, and items should be received by July 16 in order to appear in the August issue.

CHANGES OF POSITION

ROBERT MAWSON, formerly associate editor of the *American Machinist*, New York, has become identified with Mawson Brothers, general machinists, of Providence, R. I.

JOHN D. EBERHARDT has severed his connection with the Associated Factory Mutual Insurance Companies, Boston, Mass., as draftsman of the plan department, and has entered the employ of the engineering department of the Sayles Finishing Plants, Saylesville, R. I.

B. H. LISKOW, formerly affiliated with the United Engineering Company, Chicago, Ill., has become associated with the Montague Iron Works, Montague, Mich.

CLIFFORD B. LANGSTROTH, formerly supervisor of the heat-treating and drop-forge departments of the Ross Rifle Company, Quebec, Canada, has accepted the position of metallurgist with the Link-Belt Company, of Indianapolis, Ind.

JAMES G. ROLLOW has resigned as combustion engineer of the Southern California Edison Company, Long Beach, Cal., and has accepted a similar position with the E. I. duPont de Nemours and Company, with headquarters at Wilmington, Del.

WARREN P. DOOLITTLE has left the employ of the Waterbury Manufacturing Company, Waterbury, Conn., as designing engineer, and has taken a position as chief designer on development work with the United States Rubber Company, with headquarters at the Shoe Hardware Division, Waterbury, Conn.

SIEGFRIED ROSENZWEIG, formerly mechanical engineer with the Erie City Iron Works and more recently consulting engineer of the steam-engine department of the York Manufacturing Company, York, Pa., has joined the American Spray Company, New York, in a similar capacity.

FREDERICK R. PRATT has resigned his position as superintendent of mechanical construction with the Industrial Service and Equipment Company of Boston, Mass., to accept the position of mechanical superintendent with D. Goff and Sons, of Pawtucket, R. I.

C. EDWIN CLARKE, formerly master mechanic of the Cambria Steel Company, Johnstown, Pa., has assumed the duties of chief engineer of the Wilmington Steel Company, Wilmington, Del.

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THOMAS E. RAYMOND has become connected with the Massachusetts Institute of Technology, Cambridge, Mass., as assistant instructor in machine design in the department of mechanical engineering. He was until recently engineer with the Metz Motor Car Company, Waltham, Mass.

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THE NEW BOOKS

ALL books received by The Journal will be listed under this heading, generally accompanied by brief descriptive notes. Works of special importance to mechanical engineers will be commented on at length by members and others peculiarly qualified by reason of their experience and training.

Practical Safety Methods and Devices

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The author in his preface very properly sets forth the enormous human loss involved in the annual accident roll of this country. This roll now exceeds the combined annual losses of the Union and Confederate armies during the Civil War. In his introduction he gives some indication of the enormous financial losses as a result of this great waste of human power.

The book is intended to provide for employers, superintendents, foremen, underwriters, safety inspectors and engineers generally, a convenient summary of standard safety methods and devices developed and approved by those who have specialized in this subject. In the introduction the author clearly indicates that mechanical safeguards alone can only prevent about thirty per cent of the preventable accidents, while at least sixty per cent of such preventable accidents can be eliminated by suitable educational methods and regulations. He states that, in his judgment, ninety per cent of all accidents of workmen are actually preventable. He is justified in this claim on the basis of the past experience of those who have given full and careful attention to the subject in the shops. The claim which he makes that accident-prevention activity is a paying investment is also well verified by practice.

The author very properly begins the body of his work by a chapter upon the organization of safety committees. He indicates the necessity of such committees and shows how they may properly be organized for different-sized establishments. Thus, he would have a central safety committee, consisting of a trained officer of the plant, a safety inspector and a foreman or representative from each plant division. He gives very excellent tabulations of the duties of this committee and of the individuals of its constituent membership. He then shows the wisdom of having under this centralized committee, workmen's committees for each department, the membership of which is of limited duration and is arranged so that there are periodical changes of personnel. In addition to detailed information as to individual work of the inspection committees, much valuable information is given as to general educational methods. Thus the author takes up the problem of periodical talks and lectures; motion pictures where available; the use of safety bulletin boards and what they should contain; competitive team work; the offering of prizes; etc., etc.

A full discussion of the general conditions to be found in the shop is included under such headings as Guarding Machinery; Danger Signs; Clothing; Congested Work Places; Ignorance; Intoxicants; Fatigue; Illness; Thoughtlessness and Carelessness; Concentration; Instruction; Discipline; Inspection; Education of Children and Students; and the Education of the Public. These titles in themselves are illuminative and indicate the general proper treatment of the subject. A chapter is given to proper buildings and the elimination of the fire hazard. A careful discussion is made on methods of fire egress, fire fighting, fire drills and fire prevention. A very succinct and brief though satisfactory chapter is devoted to the organization and handling of fire brigades. A practical discussion ending with a set of boiler rulings is given on the type, handling, and care of boilers, following in general the instructions called for by the Code of The American Society of Mechanical Engineers. This is followed by a discussion of steam engines, care relating to their operation, safety stops, speed-limit stops, flywheels, etc. A set of engine-room rules is appended to this discussion. An even more extended discussion is given to the elevator, in which the dangers of this apparatus are clearly brought out and methods for correction given. A chapter is given on the principles of protecting against electrical hazards to life.

Following this is a chapter on transmission machinery, showing illustrated examples of many of the most important types of guards, and describing the underlying principles of such guarding. This is followed by chapters on machine tools, grinding machinery, woodworking machinery, and machines of miscellaneous types. In all of this work, evidently the attempt of the author was to lay down fundamental principles, giving, so far as necessary, illustrations.

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principles of safety and welfare in the various fields he has dealt with rather than to work out detailed safeguards and methods for each individual condition of industry. Indeed, to do the latter would require many scores of volumes the size of this one. He has apparently succeeded quite well and this book should prove a valuable reference to those engaged in industry or those who are making a study of the subject.

The author is to be particularly commended on the many compilations of practical rulings suitable for industrial practice. These have been worked in unobtrusively and without breaking the thread of the argument, and should prove of distinct value to those actually engaged in industry. The book is well printed and bound, with carefully selected and fairly clear illustrations. It undoubtedly is the result of a large amount of intelligent coöperative labor on the part of the author and his publisher.

JOHN PRICE JACKSON.

Valuation, Depreciation and the Rate-Base

Valuation, Depreciation and the Rate-Base. By Carl Ewald Grunsky, Eng. D., Member of the American Society of Civil Engineers, assisted by Carl Ewald Grunsky, Jr., E.M., Member of the American Institute of Mining Engineers. John Wiley & Sons, Inc., New York, 1917. Cloth, 5¾ x 9 in., viii + 387 pp., 27 illustrations. $4.

The purpose of the book is the discussion of the various problems connected with the valuation of property, principally that of public utilities, the proper method of treating depreciation, and the determination of a base rate which will be equitable to the public and yield a reasonable return to the owner.

The thoughts advanced are based largely on the long experience of the author in connection with such work, and are given out for the assistance of others who may be engaged in similar work, and for the purpose of developing further discussion toward the standardization of these problems.

The author urges at considerable length and forcefully that the base rate should be on the full normal replacement value, without depreciation, as against present value—used by many authorities and as ruled in many court decisions. The author's method is the proper one to follow and sets forth the principle on which all fixed charges must be estimated in any public or private enterprise which it is expected will continue for many years and beyond the life of many of the elements which go to make up the whole property.

In the consideration of normal replacement value, that is, value as determined by average costs of a series of years, it is stated that there should be added to the value of the physical property all proper overhead expenses, the cost of organization, the legitimate expenses during such a period of time as it would take under ordinary conditions to build up the business to a profitable basis, and the value of intangible property such as water rights, etc.

This statement is agreed to by most all engineers, but not always by the Courts. All of the above would seem to be proper elements of expense which must be met and a proper allowance should be made for them, the only debatable thing being the extent to which they should be carried.

The elements affecting the increase or decrease in the value of properties are discussed and recommendations made as to the proper application of the same.

The amount of unearned increment of value which should be allowed to the owners in determining the base rate is also discussed.

There is also discussed the treatment of overdeveloped properties and the wisdom of having a reasonable margin of capacity for increase in business at a reasonably early date.

The various methods of treatment of depreciation and amortization are discussed at length and the author urges with great earnestness the use of what is defined as the Unlimited Life Method for the treatment of depreciation.

The different courses followed in the valuation of property for various purposes, as purchase and sale, rate fixing, taxation, etc., are described.

The difficulties of determining with definiteness the value of mining and oil properties is explained and an argument made for the taxation of such properties based on output rather than on the physical features of the properties.

The necessity of a careful accounting system in order that all interests may be dealt with intelligently is urged.

The book contains many tables containing valuable information, and those at the end on Probable Useful Life, Expectancy and Remaining Value, and other actuarial tables, many of which have original arrangements, would be helpful to any one engaged in this kind of work.

The subject-matter is clearly developed and illustrated by many worked-out examples. The material is largely original, as is also its presentation, but it necessarily contains much which is common to textbooks on this subject.

The publication will be helpful to advanced engineers and appraisers. It is probably too far advanced to be used as a textbook for students.

CHAS. T. MAIN.

The Industrial and Artistic Technology of Paint and Varnish. By Alvah H. Sabin. John Wiley & Sons, Inc., New York, 1917. 2d ed., cloth, 6 x 9 in., 473 pp., 18 illustrations, including 8 plates. $3.50.

This book has been written to give a correct general outline of the subject, with a brief account of the modern use of paints and varnishes, and the principles involved in their fabrication and application. This edition is nearly one-third larger than the first one and takes cognizance of the changes in the character of the cheaper varnishes due to the use of tung oil.

How to Find Factory Costs. By C. Bertrand Thompson. A. W. Shaw Co., Chicago, 1917. Cloth, 6½ x 9½ in., 191 pp., 53 illustrations. $3.

The author has endeavored to make this book broad enough to apply to all kinds of industries, and it is intended to be useful to the accountant as well as the factory head. Contents: What a Good Cost System Means to You; What Goes to Make Up Your Costs; How to Handle Indirect Costs; What About Interest and Depreciation?; Charging Each Unit with Its Proper Share; The Machine Hour Rate Plan; How to Handle the Cost of Selling; Tying the Costs Into the General Accounts; An Effective System of Classification; Taking Factory Costs Apart; A Cost System that Safeguards; Making Costs and Bids Agree.

The Naval Architects' and Shipbuilders' Pocket-Book of Formulas, Rules, and Tables, and Marine Engineers' and Surveyors' Handy Book of Reference. By Clement Mackrow and Woodland Lloyd. The Norman W. Henley Pub. Co., New York, 1916. 11th ed., flexible leather, 4 x 6½ in., 742 pp., 12 illustrations. $5.

In the present edition a new section on speed and horsepower has been inserted, together with a brief description of modern methods of powering and determining forms suitable from a propulsive standpoint. The sections on strength of materials, riveted joints, and stresses in ships have been considerably extended, and information on British standard sections, screws, keys, etc., has been added.